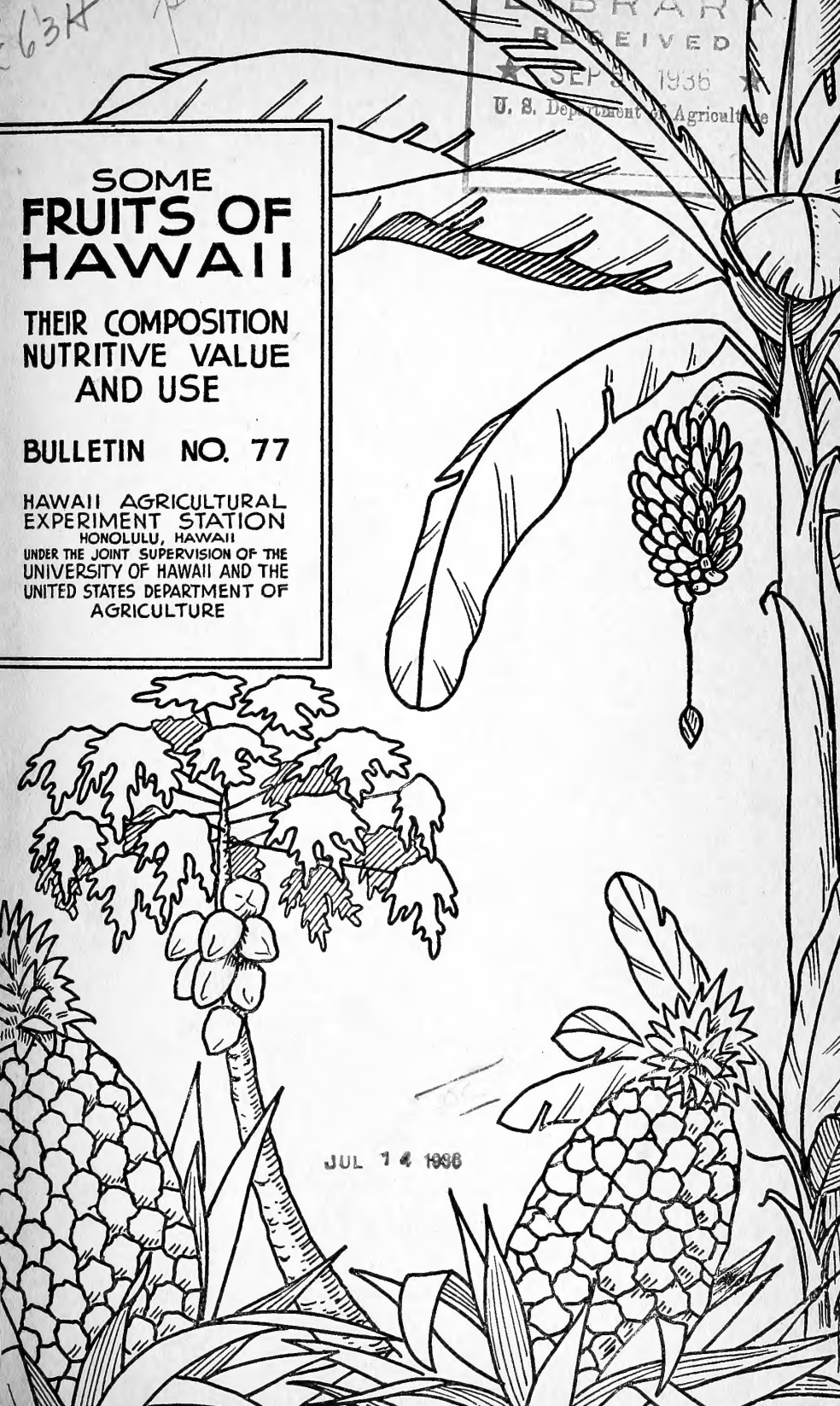
SOME FRUITS OF HAWAII

THEIR COMPOSITION NUTRITIVE VALUE AND USE

BULLETIN NO. 77

HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII
UNDER THE JOINT SUPERVISION OF THE UNIVERSITY OF HAWAII AND THE UNITED STATES DEPARTMENT OF AGRICULTURE



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(Under the joint supervision of the University of Hawaii, and the Office of Experiment Stations, United States Department of Agriculture.)

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BULLETIN NO. 77

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SOME FRUITS OF HAWAII

Their composition, nutritive value and use.

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*A portion of the historical, descriptive and chemical data in this bulletin is taken from a thesis submitted by Ruth C. Robbins in partial fulfillment of the requirements for the degree of Master of Science in Nutrition at the University of Hawaii, 1934.

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FOREWORD

Many inquiries have come to the home economics department of the University of Hawaii and to the nutrition laboratory of the Hawaii Agricultural Experiment Station regarding the use and the nutritive value of local fruits. The information previously available has been difficult of access or data have been lacking.

This bulletin aims to supply information on the most important and widely used Hawaiian fruits.[1] Many of the data have been obtained as a result of work done in the household science laboratory of the University of Hawaii and the nutrition laboratory of the Hawaii Agricultural Experiment station, but some data have been taken from other sources. Pages 5 to 102 contain non-technical information regarding the various fruits studied and recipes for their use. Pages 103 to 128 contain technical statements of the methods used in chemical analyses and vitamin determinations.

Fruits and vegetables make similar contributions to the diet, although as a group, vegetables probably contribute more of the three essential minerals—calcium, phosphorus, and iron—than do fruits. Fruits, though low in protein and in fat (with the exception of avocados), contain sufficient quantities of sugars to make them of considerable importance calorically. Of greater importance than their energy value, however, is their value as sources of minerals, vitamins, organic acids, and as roughage. The experimental work of recent years has served to emphasize these values for normal nutrition and to point out that fruits should not be classed as luxuries but should be classed with vegetables as essentials for a good diet.

The diet of many people in Hawaii is unsatisfactory and should be improved by the addition of fruits, vegetables and milk. With the opportunity of purchasing fruits at low cost and the possibility of raising them in home gardens, greater use should be made of local fruits by all economic classes in Hawaii.

Analyses of local fruits show them to be similar in composition to the same varieties of fruits grown elsewhere. The food value of some fruits is greater than that of others but attention should be called to the high nutritive value of some of our most important, widely grown and generally available fruits—namely, the avocado, the banana, the papaya, the pineapple and the guava.

It is hoped that this bulletin may stimulate the greater use of these excellent fruits.

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[1] Other fruits grown to some extent in Hawaii which have not yet been studied in the nutrition laboratory of the Hawaii Experiment Station but which have possibilities in this country as small industries are the lemon, lime, pomelo, cherimoya, sugar-apple, custard-apple, cantaloupe, persimmon and date.

The greater part of the work for this bulletin was done when J. M. Westgate was Director of the Hawaii Agricultural Experiment Station and the authors wish to express to him their great appreciation of his interest and helpful assistance.

It is not possible to mention all those who have contributed to the preparation of this bulletin. Staff members of the Office of Experiment Stations and the Bureau of Home Economics, U. S. D. A., Washington, D. C.; staff members and students of the home economics department, University of Hawaii; staff members of the Hawaii Agricultural Extension Division; staff members of the Hawaii Agricultural Experiment Station; and others outside the university have all rendered valuable assistance. Especial acknowledgment however should be made to Willis T. Pope, horticulturist, for information concerning the history, description, varieties and seasons of many of the fruits and for the photographs for the illustrations.

AVOCADO

(Persea americana)

Description: There are three races of avocados, two of which, the West Indian and Guatemalan, are common in Hawaii. The following key used by horticulturists *(44, p. 4)*[2] shows the main differences between the three races:

(a) West Indian race. Summer and fall ripening; fruit large; rind leathery and not more than one-sixteenth inch in thickness.

(b) Guatemalan race. Winter and spring maturing; fruit large; rind one-sixteenth to one-fourth inch in thickness, woody in texture.

(c) Mexican race. Leaves small and anise-scented; fruit small and thin-skinned.

The fruit is pear-shaped, round, or obovoid and sometimes weighs more than three pounds. The brilliant green skin, which changes in some varieties to red, purple, or purplish-black as the fruit matures, varies from smooth to warty in texture. The yellow or light green flesh which surrounds the single large seed is smooth in texture and of a characteristic nutty flavor. In the best varieties there is very little fiber imbedded in the flesh.

History: All races of the avocado are natives of tropical America, where they have been under cultivation for many centuries. Don Marin, the Spanish horticulturist who introduced many valuable plants into Hawaii, is credited with having started the first avocado trees in the Islands sometime before 1825 *(44, p. 2)*. As the fruit was of poor quality, the avocado did not become popular until better varieties were grown. In 1895 Rear Admiral Beardslee brought to Hawaii three Guatemalan seedlings from which many of the present varieties have been developed. In 1919 the Hawaii Agricultural Experiment Station received through the Office of Foreign Seed and Plant Introduction of the U. S. Department of Agriculture a part of a fine collection of Guatemalan avocados made by Wilson Popenoe in the highlands of Guatemala *(44, p. 3)*.

The word "avocado" is derived from the Spanish *ahuacate* or *aguacate,* which in turn was derived from the Aztec word *ahuacatl (50, p. 17)*. Many other spellings, such as albecata, arragato, avocato, have been used by various historians. The form avocado was first used in 1669 by Sir Henry Sloane who speaks of the "avocado or alligator-pear." Both of these names have persisted and are the ones common in English-speaking countries today. As the term "alligator-pear" seems objectionable, efforts are now being made to replace it by the more euphonious "avocado."

More detailed information regarding the avocado may be obtained from a previous bulletin of the Hawaii Experiment Station *(44)*.

[2] Italic numbers in parentheses refer to Literature Cited, page 129.

Nutritive value: With the exception of olives no other fruit contains as large a percentage of fat as do avocados. The fat content of avocados varies widely from 7 to 26 percent according to variety and race. The figures for water content show an equally wide variation. The caloric value of any one sample of avocados, though always great in comparison with that of other fruits, will vary according to the fat and water content, one-fourth to one-half of a medium avocado yielding 100 calories.

By means of human digestion experiments, the digestability of the oils in fresh avocados was first tested by Mattill *(28)* and found to be 93.7 percent, a value comparable to that for butter, but later experiments of a similar nature by Deuel and Holmes *(11)* gave a value of 82.5 percent.

Though a pleasant addition to any diet, avocados are especially useful in the diet of the diabetic. Because analyses *(64, p. 66)* show that avocados contain no hydrolyzable carbohydrate other than sucrose and because the total sugar content is less than one percent, for practical purposes they may be considered carbohydrate-free, even though analyses giving proximate composition indicate a carbohydrate by difference of approximately 5 percent.

The calcium content of avocados analyzed in Hawaii is only about one-fourth that reported by other investigators *(6) (66)* for avocados grown elsewhere. The phosphorus content is greater than that of many common fruits, and the iron content is relatively high[3].

Avocados are reported to be a good source of vitamins A, B, C, and G (B_2) *(39)*.

Supply:[4] Some variety of avocados is on the Hawaiian market during the entire year, the largest quantity of avocados being available in the late summer and early autumn, when the supply exceeds the demand. The hard-shell "winter" avocado is placed on the market during the months of November, December and January. The price and quality of the fruit vary greatly.

Use: The avocado is a favorite salad fruit. The most common way of serving it is "on the half shell" and in salads and cocktails. Because of the high fat content of many varieties, the avocado combines best with vinegar or with such acid fruits and vegetables as oranges, grapefruit, lemons and tomatoes. However, some Orientals prefer sugar on it instead of an acid substance. The avocado served with guava catsup makes a pleasing combination. Combined with catsup, lemon juice, vinegar or onion, the avocado makes a delicious sandwich spread. The avocado contains a tannin which causes it to develop a very bitter flavor on cooking, consequently no successful method of canning it has yet been found. It may, however, be satisfactorily used in such hot foods as vegetable soup, consomme or omelette if diced and added just before serving.

[3] On the whole, fruits do not have a high content of the three important minerals calcium, phosphorus and iron compared with such foods as milk, eggs and many vegetables. For purposes of comparison in this bulletin, all fruits containing 0.01 percent or more calcium, 0.03 percent or more of phosphorus and 0.0050 percent or more of iron will be considered as good fruit sources of these minerals.

[4] Throughout this bulletin "supply" relates to the Hawaiian Islands and sometimes more especially to the Honolulu market.

Avocado cocktail

6 servings

4½ cups diced avocado
1 cup tomato catsup
1 teaspoon finely chopped onion or juice
1½ tablespoons lemon juice
½ teaspoon Worcestershire sauce
½ teaspoon salt

Sprinkle salt over the avocado and chill. Combine other ingredients, chill, and pour over avocado just before serving.

Avocado papaya cocktail

6 servings

3 cups diced avocado
1½ cups diced ripe papaya
½ cup tomato catsup
3 tablespoons cream

Add cream to catsup when ready to serve and pour over chilled diced fruit.

Avocado grapefruit cocktail

6 servings

2½ cups avocado cubes
¼ teaspoon salt
2 cups grapefruit pieces

Cut avocado into half-inch cubes and sprinkle with salt. Remove membrane from grapefruit sections and cut them into pieces about the same size as those of avocado. Add to avocado, chill, and serve in cocktail glasses with or without cocktail sauce.

Avocado pineapple salad

6 servings

6 slices fresh pineapple
2 cups avocado slices
⅓ cup mashed avocado pulp
⅔ cup mayonnaise
2 tablespoons lemon juice

Place pineapple and avocado slices on lettuce leaves. Make a dressing of the other ingredients, chill, and pour over salad.

Avocado fruit salad

6 servings

1½ cups grapefruit sections
1½ cups orange sections
¾ cup ripe mango slices
1 cup avocado slices

Remove membrane from orange and grapefruit sections. Chill all ingredients, arrange on lettuce leaves, and serve with French dressing or mayonnaise.

Other salad combinations

Avocado may be served with sliced tomato. Combined with cabbage, celery, cucumber and onion it may be used for stuffing whole tomatoes. Avocado slices may be added to cole slaw, a mixed vegetable or gelatine salad. If one prefers sweet rather than acid combinations, avocado may be combined with apple or banana.

Avocado grapefruit salad dressing

6 servings

½ cup mashed avocado pulp ½ teaspoon salt
½ cup grapefruit juice

Press avocado through a coarse sieve if the pulp is fibrous. Add other ingredients and mix until a smooth paste is obtained. Chill and serve over lettuce.

Curried avocado

6 servings

4 tablespoons butter 1½ teaspoons salt
5 tablespoons flour 2 to 3 teaspoons curry powder
2 cups milk 2 cups diced avocado

Melt butter, add flour, and stir to make a smooth paste; stir in milk gradually, cooking until the mixture thickens. Season with curry powder, salt and pepper. Remove from fire, and just before serving add avocado. Serve with cooked rice and mango chutney.

Avocado milk sherbet

yield 1½ quarts

1 cup mashed avocado pulp 1¼ cups sugar
½ cup pineapple juice 1 cup skim milk
½ cup orange juice ¼ teaspoon salt
⅓ cup lime juice or ½ cup lemon juice

Dissolve sugar in the milk, add avocado pulp, stir well, then add fruit juice. Freeze, using 8 parts of ice and 1 part of ice cream salt.

BANANA

(Musa sapientum)

Description: Bananas, which are now one of the best known fruits throughout the world, were classed as a luxury and known to comparatively few people in the United States until late in the 19th century. Because they are so well known, a detailed description of the fruit seems unnecessary. The yellow cylindrical fruit, with the tough outer peel that acts as a prophylactic cover for the enclosed pulp, is a common sight in most parts of the world. Bananas grow in a bunch consisting of a number of clusters called "hands," each of which contains from 5 to 20 bananas.

History: The early history of the banana is closely interwoven with Eastern mythology *(15)*. The legend that the serpent which tempted Eve in the garden of Eden (Paradise) hid in a bunch of bananas influenced the classifiers to name the fruit *Musa paradisiaca* (fruit of paradise) and *Musa sapientum* (fruit of knowledge). The fact that the fruit was called "apple of paradise" or "Adam's fig" before the word "banana" was adopted from an African Congo tribe also illustrates its connections with ancient mythology. The word "banana" seems to have been used originally for only those varieties which are eaten raw and the term "plantain" for those which were edible after cooking. At present there is no clear differentiation. *(45, p. 3)*

When the early Polynesians migrated to Hawaii from the islands to the south, they undoubtedly brought with them banana plants in the form of bulblike rhizomes. These were planted in the mountain valleys where they now grow wild and were, until the introduction during the 19th century of varieties such as the Brazilian, Chinese or Cavendish and the Apple, the only kind to be had in Hawaii. The Gros Michel variety (locally called Bluefields) was not introduced into Hawaii until 1903. Some of the favorite Hawaiian varieties are the Maiamaoli, the Popoula, and the Iholena—which represent the three groups of Hawaiian bananas *(45, p. 24)*.

More detailed information regarding the banana may be obtained from a previous bulletin of the Hawaii Experiment Station *(45)*.

Nutritive value: Because bananas are an economical and nutritious food and are plentiful and available everywhere in Hawaii, greater use should be made of them.

In the half-ripe stage, one-half to one-third of the total carbohydrate may be in the form of starch. But when fully ripe and, in the case of many varieties, if the yellow skin is well flecked with brown spots, or better yet when the skin is entirely brown, almost no starch remains and practically all the carbohydrate is in the form of sugars *(12, p. 1)*.

Unripe bananas may cause digestive disturbances, but in the fully ripe stage they are readily digested and have been used successfully combined with milk in infant feeding *(24)*. There is no reason why bananas, if they are cooked or if they are used only in the fully ripe

stage, cannot be used generously in children's diets. Like most fruits and vegetables, bananas yield an alkaline ash in the body.

Because of their "filling" qualities, ripe bananas in combination with milk have been recommended as a reducing diet for the obese *(17)*. A diet consisting of two bananas and a glass of milk for the morning and noon meal and a small quantity of meat and vegetables for the third meal, is recommended for ease of preparation, low cost and availability.

Bananas are a poor source of calcium but a good source of phosphorus. According to analyses in Table 3 (p. 92), cooking bananas are a better source of iron than the common varieties of bananas eaten in the raw state.

The vitamin content of several varieties of bananas has been investigated in a number of laboratories and the results seem to justify the statement that all bananas in the ripe stage are a good source of vitamins A and C, and a fair source of B and G (B_2) *(12, p. 29)*.

Supply: Bananas are to be found on the market in Hawaii at any time during the year, the supply usually exceeding the demand, though certain varieties are not always available. It is often difficult to obtain good Chinese bananas, because most of those grown here are exported.

Use: The banana is one of the few fruits which should be picked full sized but green and which may be stored for a considerable length of time without injury to its flavor. Because cold prevents proper ripening, bananas should not be placed in a refrigerator until after fully ripened. When ripe and ready for use, the banana skin is flecked with brown spots or may be almost entirely brown. Though many people consider such bananas spoiled, they are far superior in flavor to the half-ripe ones.

Bananas may be divided into two general classes — the cooking banana, more palatable after cooking, and the eating banana, which is usually used raw but may be cooked. Most of the Hawaiian bananas (those varieties growing in the islands when they were discovered by Captain Cook in 1778) are more palatable after being cooked. Cooked ripe or green bananas may be served as a starchy vegetable, taking the place of white or sweet potatoes. In the uncooked state, they are a favorite breakfast or dessert fruit and may also be used in cocktails, salads, pies, cake fillings and ice creams.

Banana milk shake
1 serving

1 very ripe eating banana	¼ teaspoon vanilla
1 cup milk	⅛ teaspoon salt

Choose a banana with skin flecked with brown spots or skin entirely brown. Press banana through a coarse sieve. Add other ingredients gradually, stirring with a fork until thoroughly mixed. Chill thoroughly, shake in a fruit jar, and serve in a tall glass.

Sauted bananas

6 servings

4 large ripe cooking bananas
2 tablespoons butter
2 tablespoons lemon juice
2 tablespoons orange juice
2 tablespoons sugar

Peel and cut bananas into halves lengthwise. Melt fat in frying pan, brown bananas in it, add sugar and fruit juice, and simmer until bananas are soft. Serve hot as a vegetable.

Boiled bananas

6 servings

6 large ripe cooking bananas
3 cups boiling water

Wash, do not remove skins, and boil for 20 minutes in water. Drain and serve in the skin as a vegetable, or peel, and season with butter and salt.

Baked bananas in the skins

6 servings

6 large ripe cooking bananas

Wash and place in baking pan without water or with enough water to cover the bottom of the pan. Bake 30 to 45 minutes, or until soft and skins begin to burst open. Serve in skins and season with butter, salt and pepper at the table.

Bananas baked in lemon juice

6 servings

6 cooking bananas
⅓ cup sugar
2 tablespoons orange juice
½ cup orange sections
2 tablespoons lemon juice

Cut bananas lengthwise and place in baking dish. Remove membrane from sections of oranges. Arrange slices of oranges on top of bananas. Sift sugar over bananas and oranges. Add lemon juice and bake slowly for 45 minutes. Serve hot or cold.

Bananas with coconut sauce

6 servings

5 cooking bananas
⅔ cup fresh grated coconut
1 cup milk
2 tablespoons sugar

Place whole, unpeeled bananas in boiling water and cook until soft (20 to 30 minutes). Drain off water and remove skins. Make sauce by heating grated coconut in milk combined with sugar. Pour over bananas which have been cut lengthwise. Serve as a dessert, with whipped cream if desired.

Banana sandwich

Slice a ripe banana lengthwise. Place on buttered sandwich bread. Spread with mayonnaise and sprinkle with salt. Cover with a lettuce leaf and a slice of bread.

Banana butter sandwich

Spread buttered slices of whole wheat or brown bread with banana butter made according to the following recipe:

Banana butter

yield 1½ cups

1 cup ripe banana pulp
1 cup sugar
1 egg
2 tablespoons butter
4 tablespoons lemon juice

Press bananas through a sieve. Add butter, sugar, lemon juice and egg. Cook over hot water until thick as custard, or for about 5 minutes. Use for sandwich or cake filling. This recipe makes sufficient filling for a two-layer cake.

Banana waldorf salad

6 servings

1½ cups diced ripe bananas
1½ cups diced apple
1 cup diced celery
⅓ cup chopped nuts
¾ cup cooked salad dressing or mayonnaise

Have ingredients chilled before dicing, combine with nuts and mayonnaise, and serve on lettuce leaves garnished with pimiento strips or guava jelly. Do not allow salad to stand as it will darken in color.

Banana and nut salad

6 servings

3 large or 6 small ripe bananas
¾ cup mayonnaise
¼ cup lemon juice
⅓ cup chopped nuts

Peel and cut bananas in halves lengthwise. Roll in lemon juice, then in nuts, and place on lettuce leaves. Pour mayonnaise over them and serve.

Banana ice box cake

6 servings

1 tablespoon gelatin
⅓ cup cold water
1¼ cups mashed ripe bananas
¼ teaspoon salt
3 tablespoons lemon juice
6 tablespoons sugar
2 dozen lady-fingers
1¼ cups evaporated milk or whipping cream

If evaporated milk is used, heat the can in water at simmering temperature for 20 minutes. Chill evaporated milk or whipping cream thoroughly and whip with egg beater until mixture is stiff.

Soak gelatin in cold water for 5 minutes, melt by placing over boiling water and combine with mashed banana, salt, lemon juice and sugar. Cool, and when mixture begins to thicken fold in whipped evaporated milk or cream. Line pan with lady-fingers and cover with a layer of the banana-cream mixture. Alternate layers of lady-fingers with banana-cream mixture. Chill thoroughly before serving. Serve with whipped cream and garnish with guava jelly.

Banana coconut custard

6 servings

2 cups milk
2 eggs
4 tablespoons sugar
$\frac{1}{16}$ teaspoon salt
¾ cup fresh grated coconut
1 cup sliced very ripe bananas
¼ teaspoon vanilla

Beat eggs slightly; add other ingredients. Pour into a baking dish and bake in slow oven (300—325° F) for one hour.

Banana cream pie

4 to 6 servings

1½ cups milk
3 tablespoons cornstarch
½ cup sugar
1 tablespoon butter
¼ teaspoon salt
½ teaspoon vanilla
1 cup sliced bananas
2 egg yolks
2 tablespoons sugar
2 egg whites

Mix cornstarch, sugar and salt; add 3 tablespoons of the milk and mix to a smooth paste. Heat remaining milk and slowly pour in the cornstarch paste, stirring constantly. Cook over hot water 20 minutes, cool slightly, and add egg yolks slowly to the mixture, stirring rapidly. Cook several minutes until it thickens. Remove from fire, cool and add vanilla. Arrange slices of banana in baked pie shell, pour in custard mixture, and cover top with meringue made of stiffly beaten egg whites and the sugar. Brown in a slow oven (300°— 325° F) for about 20 minutes.

Banana mousse

6 servings

12 marshmallows
2 tablespoons lemon juice
⅓ cup boiling water
⅓ cup mashed ripe banana pulp
¾ cup evaporated milk or whipping cream

If evaporated milk is used, place can in boiling water and simmer for 20 minutes. Chill evaporated milk or whipping cream thoroughly and whip with egg beater.

Melt marshmallows in boiling water. Cool. Add banana pulp and lemon juice. When the mixture begins to set, fold in whipped cream. Freeze in mechanical refrigerator trays.

Three fruit ice

yield 1¾ quarts

1 cup mashed ripe banana pulp
⅓ cup lemon juice
2 cups sugar
2 cup water
1 cup orange juice

Combine the fruit juice, sugar and water. Press banana pulp through a coarse sieve and add it to the liquid ingredients. Freeze the mixture in an ice-cream freezer, using 8 parts of ice to 1 part of ice-cream salt.

FIGURE 1.—Fruit and foliage of the breadfruit. *(Artocarpus communis)* ⅛ natural size.

BREADFRUIT

(Artocarpus communis)

Description: The seedless variety of breadfruit commonly found in Hawaii and known as the Hawaiian breadfruit, is a large round or oblong fruit 4 to 8 inches in diameter. The skin, which is green in the unripe stage, acquires a greenish-brown or yellow tint as the fruit matures. The firm, mealy pulp is slightly fibrous and surrounds a tough central core. In most varieties the flesh is light creamy-yellow and has a slightly sweet odor.

History: Breadfruit trees were brought to Hawaii from Tahiti before the coming of the white man. Wilder *(71, p. 100)* states that the first suckers were brought by Hawaiians who landed at Ewa and carried them across the mountains to one of the chiefs of Oahu. In Hawaii the breadfruit has never been as important an article of the diet as in Tahiti and other south Pacific islands *(34, p. 4)*. Most ancient

sites of civilization, especially around Kona and Hilo, show large areas of cultivated breadfruit trees and the trees now grow wild in hot, moist sections of all the Islands. The Hawaiian name *ulu* corresponds to the Tahitian name *uru (71, p. 100)*.

Nutritive value: Breadfruit has about the same quantity of total carbohydrate (starch and sugar) as have sweet potatoes or taro, and more than white potatoes. Like bananas, breadfruit when fully ripe gives no test with iodine, indicating that the starch has all been changed to sugars.

"The Hawaiians never ate their breadfruit in the unripe or starchy state as did the Tahitians and Samoans. They preferred it at least half ripe or ripe" *(34, p. 5)*. The Polynesians used breadfruit as a supplement to or as a substitute for taro and sweet potatoes, and there seems to be no reason why it should not be so used today.

The calcium content of breadfruit is higher than that of white potatoes and about the same as that of sweet potatoes and taro. These vegetables all have about the same quantity of phosphorus, but taro and sweet and white potatoes are superior sources of iron.

Cooked breadfruit is a fairly good source of vitamin A and of the vitamin B complex, and is a poor source of vitamin C *(34, p. 22)*. No experiments to test the vitamin G content of breadfruit have been reported.

Supply: Breadfruit may be purchased in the market at intervals from July to February and occasionally at other times during the year. Although breadfruit seems to be plentiful, the quantity reaching the market does not exceed the demand.

Use: The breadfruit may be picked in the *tepau* stage, when the milky sap comes to the surface, but while the fruit is still firm, green and starchy, or if a riper and therefore sweeter stage is desired, it may be picked when the skin is yellow green or just beginning to turn brown. It is always cooked for use, and if boiled in the *tepau* stage it is an excellent food resembling the potato in flavor. If to be used ripe, the fruit should be kept until it becomes soft and the outside skin partially brown in color. The ancient Hawaiians cooked the whole breadfruit in the underground oven or *imu*. Today it is usually baked or steamed. After cooking it may be made into *poi* and used as a substitute for taro *poi*, or may be combined with it. However, breadfruit *poi* is not as commonly used by the Hawaiians as by other Polynesians *(34, p. 5)*.

Baked breadfruit

Choose a ripe breadfruit which is soft, with the small sections of the skin flattened and partially brown in color. Wash, and bake whole in a moderate oven (350° F) for 1 hour. Remove from oven, pull out core and stem, cut breadfruit in half, and season with butter, salt and pepper or butter and sugar. If preferred, remove the core and stem before baking, place 1 tablespoon butter and 1 tablespoon sugar in the cavity and replace stem during baking period. Place breadfruit in a pan containing just enough water to keep pan from burning.

Steamed breadfruit

Remove skin, stem and core from a soft ripe breadfruit. Cut breadfruit into halves or quarters, place on a pan and steam in a covered steamer for 2 hours, or until thoroughly cooked. Season with butter, salt and pepper.

Breadfruit and coconut pudding—*Papaiee*

6 servings

3 cups ripe breadfruit pulp
1½ cups coconut milk extraced from 1 grated coconut with 1 cup boiling water
½ cup sugar
½ teaspoon salt

Pour boiling water over grated coconut and allow to stand 15 minutes. Strain though two thicknesses of cheesecloth, squeezing out as much milk as possible. Scrape out the pulp from soft ripe breadfruit and add coconut milk, salt and sugar. Pour into an oiled baking dish and bake one hour or more in a moderate oven (350° F).

Breadfruit chowder

6 servings

2 thin strip of bacon
⅓ cup sliced onion
2 cups diced raw green breadfruit
½ cup diced raw carrots
2 teaspoons salt
3 cups boiling water
1⅓ cups milk

Cut bacon in small pieces and fry until light brown, add onion and cook until a light brown color. Add vegetables, salt, and water; boil until vegetables are tender. Add the milk and serve hot.

Boiled green breadfruit

6 servings

4 cups diced green breadfruit
3 cups boiling water
¾ teaspoon salt
pepper to taste
3 tablespoons butter

Choose a breadfruit which is still quite firm and green in color; peel and dice it. Cook in boiling salted water about 1 hour or until breadfruit is tender; drain off excess water, season with butter, salt and pepper, or with salt and sugar. This may be served as a starchy vegetable.

FIGURE 2.—Fruit, foliage and cross section of the carambola. *(Averrhoa carambola)* 3/8 natural size

CARAMBOLA

(Averrhoa carambola)

Description: The carambola is a translucent yellow or yellow-green fruit 4 to 5 inches in length and about 2 inches in diameter. It has 5 prominent ribs which make it distinctly star-shaped in cross section. The thin, waxy skin encloses a very juicy pulp and several smooth brown seeds. There seem to be two varieties, distinguished as the sweet carambola and the sour carambola. Both are quite mild in flavor.

History: Like many other fruits found in Hawaii, the carambola is believed to be a native of the Malayan archipelago and to have been taken from there to America at an early date *(50, p. 430)*. The history of its introduction into Hawaii is not known, but the tree may have been brought from Southern China by the early Chinese immigrants or by sandalwood traders.

Nutritive value: The carambola juice contains about 10 percent of sugar. In comparison with other fruit juices it has a very small percentage of calcium and iron but contains about the same amount of phosphorus.

No investigations of the vitamin content of carambolas are reported in the literature and no tests have been carried out in the Station laboratory.

Supply: The carambola is rarely found in the markets, as it is grown chiefly as an ornamental shrub. It ripens during November and December.

Use: The watery pulp of the fruit has a pleasant taste, and is refreshing to eat when ripe or to use in an iced drink. An unpleasant bitter flavor develops when the fruit or juice is cooked or canned. Although the fruit contains a small quantity of pectin, it is not recommended for jelly making.

Sweet carambolade

6 servings

2 cups sweet carambola juice — 4 cups cold water

Wash carambolas, cut into small pieces, and press juice through a sieve or coarse cloth. Mix with water and pour over cracked ice.

Sour carambolade

6 servings

2 cups sour carambola juice — ¾ cup sugar

4 cups cold water

Wash carambolas, cut in small pieces, and press through sieve or coarse cloth. Add sugar and water to juice, and pour over cracked ice.

Sour carambola sherbet

yield 1½ quarts

1½ cups fresh carambola juice — ⅞ cup sugar

1⅓ tablespoons lemon juice — 2 cups boiling water

1 teaspoon gelatin — 1 tablespoon cold water

Soak gelatin in cold water. Add sugar to boiling water and boil for 5 minutes. Remove from fire and add gelatin, stirring until it is dissolved. Cool to lukewarm, add fruit juice, and freeze, using 8 parts of ice to 1 part of ice-cream salt.

COCONUT

(Cocos nucifera)

Description: The coconut is the large, one-seeded fruit of the cocopalm (*Cocos nucifera,* Linnaeus) in which the endosperm within the nut is the edible portion. The fibrous husk encloses the brown, hard-shelled nut, 4 or 5 inches in diameter. G. P. Wilder states *(72)*: "After being fertilized by the adjacent staminate flowers, the hollow interior of the shell becomes filled with sweet water. The spherical fruits gradually increase to from 4 to 8 inches in diameter. The endosperm, at first an opaque, jellylike substance, forms in the inner walls of the shell, and gradually absorbs the water; it attains a firm thickness of from 0.25 to 0.5 inches. This is known as the 'coconut meat' and forms an important article of diet for the Polynesian people." In the early stages the meat is soft and jellylike and is known as "spoon coconut," because it must be eaten with a spoon. Later the meat becomes crisp and firm.

History: There are several varieties of coconuts growing in Hawaii at the present time, most of which have been introduced within the last century. Those growing in the Islands at the time of the arrival of the first missionaries were small and of inferior quality and are often called Hawaiian coconuts to distinguish them from later introductions. This original strain or variety was probably brought to Hawaii by the early Polynesians when they migrated from the islands to the south. The many varieties of coconuts have not been classified botanically. The Hawaiians and South Sea Islanders distinguish the varieties by differences in the color and texture of the husk, the thickness and flavor of the meat, and the amount of oil present. Although the Hawaiian Islands are near the northern limit for the growing of coconuts, many excellent varieties thrive, but they do not bear as abundantly here as farther south *(20, p. 452)*.

Nutritive value: The chemical composition of the edible portion of the coconut varies with the stage of development. Isles *(23)* has studied the composition of the meat and the water from within the cavity of coconuts from the very young stage to complete maturity. In the present bulletin the watery liquid from within the coconut is called "water" and the expressed juice obtained from squeezing the grated coconut meat is called "milk."

According to Isles' data, the water at the very earliest stages, when the white meat has not yet formed within the shell, contains 1.2 to 2.8 percent of invert sugar but no sucrose. But when the meat begins to form, sucrose appears in the water, and as the nut matures there is no marked change in the percentage of invert sugar and sucrose present. The highest figure given by Isles for sucrose of the water is 0.96 percent and the lowest figure 0.13 percent. The protein and fat content is negligible. No figures for ash content of the water are given.

The water from immature coconuts was previously shown *(34, p. 14)* to contain as much calcium as some fruits and vegetables, if not more.

The figures in Table 3 confirm this data and show that only four fruits analyzed in this series have a higher calcium content than coconut water from the very immature nuts. The phosphorus content is variable and lower than previously reported, and the iron content is negligible. Immature coconuts contain from 300 to 700 cc. of water.

Coconut water has an acid reaction. Samples of water from very young coconuts having little or no meat were tested in the station laboratory and found to have an average pH of 4.7.

The results of experiments on guinea pigs summarized in Table 10 show that the water from immature nuts has some antiscorbutic value, but at least 20 cc. daily is necessary to protect the animals from gross scurvy. Axtmayer *(2)* has tested the water from ripe nuts and concludes that it is a poor source of vitamin B and a relatively good source of vitamin G.

The southern Polynesians *(34, p. 13)* and other peoples inhabiting tropical islands where coconuts grow make great use of coconut water, and early voyagers in the Pacific area relate that they drank the coconut water offered them by the natives *(34, p. 13)*.

According to Isles *(23)*, the meat begins to form when the nut is about six months old, counting from the time when the spathe first opens. As the meat develops, its water content gradually decreases, the fat and total ash increase, and the protein and sugar content show less marked changes. The meat of mature coconuts contains a relatively large amount (5.4 percent, fresh basis) of crude fiber *(64) (26)*.

The analyses of the expressed coconut milk show *(34, p. 14)* it to be high in fat (27.0 percent) and low in protein (4.0 percent), and it has been pointed out that "neither coconut water nor coconut milk are comparable to cow's milk in organic nutrients or calcium and phosphorus content" *(34, p. 14)*.

Coconut in any form contains little or no vitamin A. The meat from ripe coconuts is a good source of vitamin B, but the expressed milk is a poor source. Mature coconuts are reported to be a good source of vitamin G but to contain no demonstrable quantity of vitamin C *(60, p. 628)*.

Supply: Though the retail demand is small, coconuts are available all year round and may be purchased in all the larger markets and at many roadside stands.

Use: Coconuts are plentiful in the Hawaiian Islands, but they are not very generally used. The labor and time required to prepare them for use is no doubt responsible for this. Considerable time and effort may be saved by using a grater such as the Hawaiians and Samoans use. The accompanying drawing shows a grater made from a piece of iron 5½ inches long, 1½ inches wide, and ¼ inch thick, having one end flattened and slightly curved upward with teeth ⅛ inch wide and ⅝ inch long. This metal piece may be nickel plated in order to prevent rusting, the total cost being approximately two dollars. The metal grater may be screwed onto a straight piece of wood or better to a wooden seat as shown in Figure 3. The coconuts should be separated into halves but the meat should not be removed from the shell as is necessary for other

types of graters. To use the coconut grater place it on a chair, sit on the wooden seat in order to hold it firmly in place, hold a piece of coconut in both hands and scrape the meat over the metal grater so that the grated coconut drops into a pan which has been placed underneath the grater.

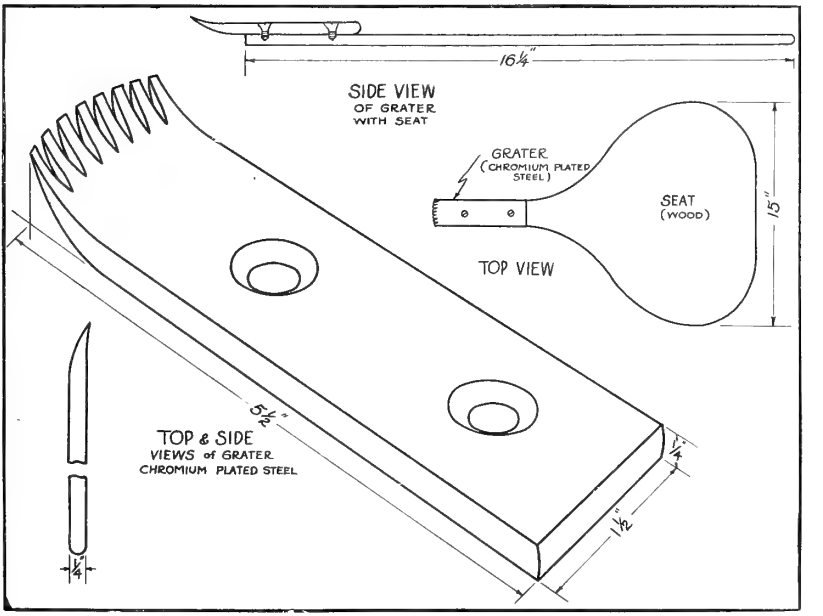

FIGURE 3.—Diagram of coconut grater.

For some uses the coconut may be prepared by putting the meat through a vegetable grater or meat grinder.

Coconuts are used in different stages of ripeness. The young nuts, called "spoon coconuts," which have a thin layer of very soft meat, may be chilled and served—the meat to be eaten with a spoon and the liquid drunk through a straw. Halves of the young coconuts with the adhering soft meat may be used as individual containers for fruit cocktail.

The milk extracted from the grated coconut meat may be used in place of cow's milk in curries, coconut puddings, and in frozen desserts. The Hawaiians add the coconut milk to cooked chicken, fish, or taro leaves near the end of the cooking process. Polynesians also combine the milk with banana, sweet potato and taro in baked or steamed puddings. Other favorite ways of using fresh grated coconuts are in candy, cake icings and pies.

Coconut milk

Choose a coconut which is not fully mature. Have the outer husk removed from the nut. Using a nail or ice pick, open the two soft eyes at the end of the nut. Drain the water from the inside. Crack nut with a hammer and remove the meat. Grate the meat, or put it through a vegetable or meat grinder. If the Hawaiian type of grater is used, it is not necessary to remove the meat from the shell. When grated, a medium-sized coconut usually yields 3 cups. If a thick coconut milk to serve over puddings, taro leaves, etc. is desired, ½ to ¾ cup of coconut water or boiling water should be poured over the 3 cups of grated coconut. Allow it to stand 15 minutes and squeeze through *poi* cloth or two thicknesses of cheesecloth. If the milk is to be used in curry sauce for chicken, eggs, shrimps, or in cornstarch pudding, a larger quantity of water (1 to 2 cups of water to 3 cups of grated coconut) may be used. The coconut meat will still retain sufficient flavor to be used in candy or macaroons.

Haupia—coconut pudding

6 to 8 servings

3 cups grated fresh coconut (1 coconut)
2 cups boiling water
} yields 3 cups extracted coconut milk

For soft pudding— 3 tablespoons cornstarch

For stiff pudding— 6 tablespoons cornstarch

2½ tablespoons sugar

Pour boiling water over grated coconut and allow to stand 15 minutes. Strain through double thickness of cheesecloth or *poi* cloth, squeezing out just as much of the milk as possible. If this does not yield 3 cups, add water poured from the inside of coconut to make that amount. Mix cornstarch with sugar, and add sufficient coconut milk to make a smooth paste. Heat remaining milk to boiling, slowly stir in cornstarch paste, and boil until it thickens. Pour into mold and allow to cool. For stiff pudding, cut into 2-inch cubes, and serve on squares of *ti* leaves in the Hawaiian style.

Coconut confection

yield 1 pound

4 cups fresh grated coconut
⅞ cup sugar.
¼ cup corn syrup
2 egg whites

Place grated coconut with corn syrup and sugar in the top of a double boiler. Stir while cooking until mixture clings to spoon. Add egg whites and cook until mixture feels sticky when tried between the fingers. Spread in a wet pan, cover with wet paper and cool. Chill by placing pan on ice in refrigerator. Shape into balls, dipping the hands in cold water first. Use about 1½ tablespoons each, making 40–50 balls. Warm a baking sheet and rub over lightly with paraffin or oil. Place balls on sheet, flatten slightly and bake in a slow oven (300°–325° F) 30 to 40 minutes.

Coconut candy
yield 1½ pounds

3 cups sugar 1 cup water
3 cups fresh grated coconut

Combine the water and sugar. Heat the mixture slowly, stirring until the sugar is dissolved, then boil until it spins a thread (235° Fahrenheit). Remove the crystals from the side of the pan with a fork wrapped in a damp cloth or cover the pan for 2 or 3 minutes until the crystals are dissolved.

Remove the syrup from the fire, stir in the coconut, place over the fire and boil slowly 10 minutes (224° Fahrenheit). Remove from fire and stir the mixture vigorously until it becomes creamy and is of the proper consistency to drop from a teaspoon on wax paper.

This candy is soft immediately after making but hardens slightly on standing and keeps well.

Coconut candy
yield 1½ pounds

3 cups fresh grated coconut ½ cup milk
3 cups sugar $\frac{1}{16}$ teaspoon salt
¾ teaspoon vanilla

Mix coconut, sugar, salt and milk thoroughly. Place over a low fire and bring to a boil, cook about 5 minutes or until the mixture appears glassy around the edge of the pan. Stir frequently. Remove from the fire and beat 5 minutes until partially cool. Add vanilla and drop from a teaspoon on waxed paper. This candy should be used the day it is prepared, for it becomes sugary after standing.

Waikiki coconut cream pie
4–6 servings

2 cups milk 3 tablespoons cornstarch
3 egg yolks ½ teaspoon vanilla
½ cup sugar ½ cup whipping cream
$\frac{1}{16}$ teaspoon salt ¾ cup fresh grated coconut

Combine the sugar, cornstarch and salt. Scald the milk and add the dry ingredients slowly to the hot milk, stirring until a smooth mixture is obtained. Cook over hot water, stirring frequently. Cool the mixture to lukewarm and stir in the egg yolks. Cook over hot water until the custard thickens. Cool, add vanilla, and pour into a baked pie shell. Chill and whip the cream. Just before serving spread the custard with the whipped cream and sprinkle with coconut.

Coconut cream pie

4–6 servings

⅔ tablespoons gelatin
3 tablespoons water
1⅓ cups scalded milk
2 eggs
¼ cup sugar
1/16 teaspoon salt
½ teaspoon vanilla
¾ cup fresh grated coconut

Soak gelatin in the cold water. Add sugar and salt to egg yolks and slowly add the milk. Cook this mixture over hot water, stirring until the custard mixture thickens and coats the spoon. Do not allow the water to boil, because the custard will curdle. Remove from the fire, add the soaked gelatin to the custard, stir until it is dissolved, and set the mixture in a cold place. When slightly thickened, stir in the vanilla and one half of the coconut, then fold in the stiffly beaten egg whites. Pour into a baked pie shell and sprinkle the remaining coconut on top. Set in the refrigerator for 2 or 3 hours before serving.

Coconut turnovers

yield 20 turnovers

2 cups flour
⅔ cup fat
¾ teaspoon salt
¼ cup water
3 cups fresh grated coconut
½ cup butter
1 cup sugar

Sift the salt and flour together, cut or rub in the fat until well blended, add the water slowly to make a stiff paste. Roll out on a slightly floured board to a thickness of ⅛ inch. Cut 4 inch circles for the turnovers.

Cream the butter and sugar well, add the coconut and mix thoroughly. Place about 2 tablespoons of this mixture on each circle of pastry. Fold pastry over to form a semi-circle and pinch the edges together. Bake in a hot oven (450° F) for 30 to 40 minutes.

Hawaiian freeze

yield 1½ quarts

6 cups grated coconut (2 coconuts)
3½ cups boiling water
} yields 4¼ cups extracted coconut milk

⅞ cup coconut water
1⅛ cups sugar
½ teaspoon vanilla

Pour the boiling water over the grated coconut and allow to stand 15 minutes. Strain through poi cloth or a double thickness of cheesecloth, squeezing out as much of the milk as possible. Add the coconut water, sugar, and vanilla to the extracted coconut milk, and stir until the sugar is dissolved. Freeze in an ice-cream freezer using 8 parts of ice to 1 part of ice-cream salt.

Grated coconut may be served over the frozen mixture.

COFFEE

(Coffea arabica)

Description: The familiar brown coffee grains of commerce are the roasted and ground seeds or beans of the coffee plant. The fruit of the coffee is dark crimson when ripe and consists of a fleshy portion surrounding the two seeds, giving rise to the name "coffee cherry" for the fruit. Ukers, the coffee authority, states that *(68)* "All Hawaiian coffee is high grade; and is generally large bean, blue-green in color when new crop, and yellow-brown when aged. It makes a handsome roast and has a fine flavor that is smooth and not too acid. It blends well with any high-grade, mild coffee. . . . Old-crop Kona coffee is said by some trade authorities to be equal to either Mocha or Old-Government Java."

History: Coffee is believed to be indigenous to Abyssinia and from there spread at an early date to Arabia, the inhabitants of which still use coffee very extensively. Since the introduction of coffee to the Western hemisphere, the cultivation of coffee has spread to most warm, moist regions. The first record of planting coffee in Hawaii is found in Don Marin's diary on December 30, 1817, *(74, p. 47)* but apparently the plants did not grow. Dr. William Hillebrand *(20, p. 176)* reports that coffee trees were introduced in 1823 by a Frenchman who started a small coffee plantation in Manoa Valley, Oahu, but G. Rhodes, in 1851, reported to the Royal Hawaiian Agricultural Society *(56)* that coffee trees were first brought to Hawaii from Rio de Janeiro by Lord Byron on the English ship "Blonde" in 1825. Since then, there have been many later introductions and the industry has been developed in the Kona district of Hawaii where coffee of a distinctive flavor and aroma is now grown.

Nutritive value: Coffee has no energy or caloric value and is devoid of minerals and vitamins.

The characteristic flavor and aroma of coffee are said to be chiefly due to the volatile oil caffeol. *(60, p. 529)*

Most people drink coffee for the stimulating action which is attributed to the alkaloid, caffeine. The effects of this alkaloid have been the subject of much scientific investigation, the results of which have not always been in agreement *(70)*. Some points on which they do agree are that caffeine is a cardiac stimulant, that it increases the basal metabolic rate, increases uric acid production, acts definitely as a diuretic and as a nervous and mental stimulus. This recent review concludes "whether the constant use of caffeine beverages is harmful, harmless, or merely indifferent is still a debated question. Perhaps the majority of workers believe that normal adults may indulge in moderate amounts without injury, or possibly even with benefit to themselves." It should be noted that this last statement refers to normal, healthy people. The practice to be followed by individuals who deviate from the normal is a matter for the decision of a physician. However, the report emphasizes that "whatever the difference of medical opinion may be concerning the ultimate effect of caffeine beverages on adults, all authorities are agreed that their use by children is contraindicated."

Supply: In the Kona section of Hawaii, the largest part of the crop of coffee berries ripens between the middle of October and the middle of December. However, ripe beans may be found during the entire year on trees growing at different levels. The total green coffee production for the crop year 1933-34 amounted to 10,387,629 pounds, of which 54.4 percent, or 5,650,325 pounds, was shipped to the mainland; 22.1 percent, or 2,293,064 pounds, was exported to foreign countries, leaving a balance of 23.5 percent, or 2,444,240 pounds, roasted in the Territory and marketed mostly as "Kona" coffee.

Use: Kona coffee is used extensively as a beverage in the Hawaiian Islands and is shipped to the mainland where it is used in blended coffees. The addition of a strong coffee infusion as a flavoring material to ice cream, whipped cream or gelatin desserts makes a pleasing variation for the diet.

Preparation of Hawaiian coffee

A comparison of the boiling, percolating and steeping methods of making a beverage from Hawaiian coffee showed that steeping the very finely ground or pulverized coffee for two minutes proved superior to the other methods. A five year old Hawaiian coffee, freshly roasted, gave better results than coffee not so well aged before roasting. For the steeping method*, an earthenware or glass pot is more desirable than a metal one. Two level tablespoons of finely ground coffee are used to each half-pint measuring cup of boiling water. The water is poured over the ground coffee and allowed to steep 2 minutes and immediately filtered off. This gives a clear infusion with a good flavor.

In preparing boiled and percolated coffee, 1½ tablespoons of finely ground coffee and 1 measuring cup of cold water, boiled or percolated for 5 minutes give a product equivalent in strength to the steeped coffee but not as clear.

Beverages made from five year old Hawaiian coffee were compared with products prepared from two well-known blended coffees made by the different methods. The Hawaiian coffee seemed as strong as the two samples of blended coffee although there was a difference in flavor. There seems to be no reason for using a larger quantity of Hawaiian coffee than other coffees when there is a short steeping, boiling or percolating period.

* Johnson, Helen L.—Scientific Coffee Brewing—Results of Research Done in Dept. of Biology and Public Health, Mass. Institute of Technology, 64 Water Street, New York City.

FIG

(Ficus carica)

Description: Different varieties of figs vary greatly as to size and color of flesh and skin. The leading variety of fig grown in Hawaii is known as the "Turkish Brown" or "Brown Turkey." It is pear-shaped, 1½ to 3 inches in diameter, and mainly of a mahogany brown color. The thin, easily bruised skin encloses a soft pinkish-white pulp and many tiny seeds. The fruit matures from a large number of small flowers which develop within a protecting shell. This accounts for the small hollow in the center of the pulp around which can be seen a layer of seeds and tiny dried flowers. The flavor is sweet and pleasing.

History: The fig has been under cultivation for many centuries and is mentioned in the oldest European literature. Some variety was probably introduced into Hawaii near the beginning of the 19th century, as Don Marin records in his diary that figs were growing in his garden in 1809 *(74, p. 46)*. This variety, which was probably the mission fig from the Spanish missionaries in California, did not thrive at that time; but it has been recently introduced again and, with the Kadota, is reported to be growing successfully on the Island of Hawaii. The Brown Turkey is grown on all the Islands.

Nutritive value: The fig is an excellent fresh fruit with a low acid and a high sugar content.

Compared with other fruits analyzed in this study, figs are a good source of calcium and are commonly eaten in larger quantities than several fruits which contain a higher percentage of this mineral.

Morgan and coworkers *(37)* reported fresh California figs to be a poor source of vitamin C and a fair source of vitamin A.

Biological tests in the station laboratory have shown the Brown Turkey variety to be a fair source of vitamins A, B and G and a poor source of vitamin C.

Supply: The supply of best quality figs does not equal the demand at any time. They ripen throughout the year, but the main season is from May through July.

Use: Practically all the figs produced here are used in the fresh state. Superior flavor and texture may be had only in thoroughly ripened figs, therefore they should not be used in the half-ripe stage. A favorite way of serving them is as a breakfast or dessert fruit with cream and sugar. Excellent shortcakes, sherbets, puddings, preserves and jams may be made from them.

Fig cocktail

6 servings

4½ cups ripe figs (2¼ pounds)	2 tablespoons sugar
½ cup orange juice	2 tablespoons lemon juice

Wash, peel and cut figs in small pieces. Add sugar to fruit juice and pour over the figs. Chill and allow to stand 1 hour before serving in cocktail glasses.

Fig litchi cocktail

6 servings

3 cups fresh figs, peeled and cut in cubes (1½ pounds)
2 tablespoons lemon juice
½ cup liquor from canned litchis
1½ cups canned litchis (10-oz. can)

Wash, peel and dice figs. Cut litchis in quarters. Combine all ingredients and allow to stand in a cold place for 1 hour before serving in cocktail glasses.

Fig jam

yield 1½ quarts

10 cups figs, chopped and peeled (5 pounds)
5⅓ cups sugar
½ cup lemon juice

Peel and chop figs. Add sugar and lemon juice, then boil 1 hour, or until thick. Stir frequently to prevent scorching. Pour into hot sterile jars and seal with paraffin. 1½ tablespoons finely chopped fresh ginger root may be added if desired.

Preserved figs

yield 2 quarts

4 pounds or 24 firm ripe figs
8 cups sugar
½ cup baking soda
3 quarts boiling water
4 quarts water

Combine soda and 3 quarts of water, heat to boiling, and add figs a few at a time; allow to remain 15 minutes without additional heating. Remove figs and wash in several changes of clear water. Remove any undesirable spots from figs, peel, and place in cold water until ready for cooking. Prepare a syrup by boiling together the sugar and water. Add figs so that there will be just one layer of figs in each kettle and cook without stirring for 2 hours, or until figs are clear and glossy in appearance, and temperature of syrup is 224° F. Carefully lift out figs, place them in a shallow pan, and pour syrup over them until fruit is entirely covered. Cover and allow to stand over-night to "plump."

Pack figs in hot sterilized jars, heat syrup to boiling and pour over figs. Partially seal jars and process 15 minutes in hot water bath. Have more than enough boiling water to cover jars and keep boiling during the processing. Remove jars, seal and label. These figs may be served with the main course of the meal or a delicious salad may be made by stuffing drained figs with cottage cheese and serving with mayonnaise and nuts.

Fig filling for cake

yield 1½ cups

2 cups chopped peeled figs
⅔ cup sugar
⅔ cup water
2½ tablespoons lemon juice

Mix ingredients together and cook 45 minutes, until figs are soft and mixture is thick enough to spread. Cool and spread between layers of plain yellow or white cake.

Fig sherbet

yield 1½ quarts

4 cups strained ripe figs
¾ cup sugar
⅔ cup water
4 tablespoons lemon juice
3 tablespoons pineapple juice
2 egg whites

Chop figs and put through a strainer. Combine sugar and water, boil 3 minutes, cool, and add fruit and unbeaten egg whites. Freeze, using 8 parts of ice to 1 part of ice-cream salt.

Fig ice cream

yield 1¾ quarts

3 cups strained ripe figs
1½ cups thin cream
1 cup sugar
¼ cup lemon juice
1½ cups milk

Chop figs and put through a strainer. Add remaining ingredients and freeze, using 8 parts of ice to 1 part of ice-cream salt.

Fig mousse

6 servings

1¼ cups strained fresh fig pulp
16 marshmallows
½ cup boiling water
2 tablespoons lemon juice
1¼ cups whipping cream

Melt marshmallows in boiling water. Add fig pulp and allow to stand until mixture is partially congealed. Chill and whip cream until it is stiff. Fold whipped cream into the other mixture and freeze 4 to 6 hours in a mechanical refrigerator pan or in a tightly sealed mold packed in ice and salt (3 parts of ice to 1 part of ice cream salt).

ISABELLA GRAPE

(Vitis labrusca)

Description: The Isabella grape, the only variety of grape grown commercially in Hawaii, is an American seedling grape of the slipskin type. The bunches are from 4 to 6 inches in length and very firmly packed. The individual grapes are a deep purple-black with a light blue bloom when ripe, and are about a half inch in diameter.

History: Grapes, grown throughout most of the world, are of many different types. They were introduced into Hawaii at an early date, as Captain Vancouver speaks of leaving grape vine plants and orange plants on March 4, 1792 *(74, p. 46)*. Don Marin also speaks of his vineyard in his diary in 1815 and records the making of wine *(74, p. 47)*. The grape grown by him was probably the Mission grape from California, which has since disappeared. The date of the introduction of the Isabella grape into Hawaii is not known, but must have been after 1816, the date of the discovery of the Isabella as a seedling in South Carolina *(18, p. 310)*. Because it is grown largely by the Portuguese in Hawaii, it is often erroneously called a Portuguese or European type of grape.

Nutritive value: Grapes are of value in the diet largely because of their distinctive flavor and refreshing qualities. Their sugar content is similar to that of other fresh fruits of the same water content.

The analyses of the Isabella variety show that the quantity of calcium, phosphorus and iron of the seeded grapes (i.e., those with the seed removed) with the skins is higher than in those without the skins. In either form the Isabella grapes are only a fair source of these three minerals, though the quantities found for this variety are somewhat smaller than the average quantities for grapes reported by Sherman *(59)*.

No tests were made to determine the vitamin content of the Isabella grapes, but Daniel and Munsell *(9)* have shown that the closely related Concord grape contains very little vitamin A or B and no vitamin C or G. For their experiments they used the juice and pulp of the Concord grapes and suggest that possibly the skins, which were discarded, may have contained some vitamins.

However, the same authors *(10)* report experiments using Sultanina and Malaga grapes with skins and conclude that they contain only small amounts of vitamin A, fair amounts of vitamin B, little or no vitamin G, and very little vitamin C.

The conclusion that grapes of any variety contain only small or negligible quantities of all the vitamins seems justifiable.

Daniel and Munsell *(10)* have shown that commercial grape juice contains no demonstrable quantities of any of the vitamins.

The acids of Concord grapes have been shown *(40)* to consist of approximately 60 percent malic acid and 40 percent tartaric acid, a large portion of which exists in the form of alkali salts. Citric and malic acids are well oxidized by the body *(60, p. 403)*, but scientists do not agree regarding the fate of tartaric acid in the human body. Though

the subject has been much investigated (*14*) (*52*) (*53*) (*57*) (*58*), it is still under dispute.

That tartaric acid (sodium tartarate) is burned in the human body is highly questionable (*14*), but that grapes and grape products cause the urine to become more alkaline seems to have been well established (*52*) (*53*) (*57*). This increased alkalinity may come about partly because bacteria in the intestine break down the alkali salts of the tartaric acid, thus releasing the basic elements, and partly because more than half of the acidity is due to malic acid or its salts which are oxidized.

Supply: The supply available for the market is irregular and does not equal the demand. The main crop comes to the market in the summer but some fruit may be seen during the other months of the year.

Use: This grape may be eaten fresh or used in making jelly, grape juice or conserves.

Grape juice

5 pounds yield 2 quarts of juice

Wash sound, ripe grapes, cover them with water, and heat slowly to the simmering point. Cook slowly until the fruit is very soft; then strain through a jelly bag made of flannel or two thicknesses of a flour sack. Measure juice, place on fire, bring to boiling point, and add ½ cup of sugar to each quart of juice. Boil 5 minutes, pour into hot sterilized jars or bottles, and seal at once. Jars may be processed from 10 to 15 minutes at 5 pounds pressure in pressure cooker or in oven 68 minutes at 250° F.

Grape butter may be made from the pulp.

Grape jelly

5 pounds yield 5 cups of jelly

Choose half-ripe grapes, discard stems and spoiled grapes. Wash, and place grapes in a kettle with water. Use ⅓ pound of water, or ⅔ cup, for each pound of grapes. Cook slowly until fruit is very soft, and strain through bag of flannel or two thicknesses of flour or sugar sack. Do not squeeze the bag if a very clear jelly is desired.

A test for pectin may be made by adding 1 tablespoon of alcohol to 1 tablespoon of juice. If the mixture becomes thick and gelatinous, there is a considerable amount of pectin present and 1¼ cups of sugar may be used to 1 cup of juice. If the pectin mass is not very thick, 1 cup of sugar to 1 cup of juice usually proves to be the best proportion.

Grape jelly should be made in small quantities, not over 3 cups of juice at a time, and the total boiling period should not be longer than 10 minutes. Measure the juice and place it in a shallow kettle with a capacity at least 4 times the volume of juice. Bring to the boiling point and boil rapidly for 5 minutes; then add the sugar, and remove the scum as the mixture starts to boil. Boil rapidly until the juice gives the jelly test (sheets off in large drops from a spoon). Pour into hot sterile jelly glasses and seal with paraffin.

Grape butter may be made from the pulp.

Grape conserve

yield 2½ quarts

4 pounds grapes or 6⅔ cups pulp and skins after cleaning
2½ cups chopped English walnuts
5 cups sugar
2 cups seedless raisins

Wash and pick over ripe grapes. Remove skins and heat pulp slowly until soft enough to press out seeds by rubbing pulp through a sieve. After seeds are removed, combine pulp and skins. Look over raisins, remove stems and wash. Combine grapes, raisins and sugar. Boil for 5 minutes, add nuts, and cook 5 minutes longer. Pour into hot sterile jars and seal with paraffin.

Grape butter

yield 1 quart

3 cups grape pulp from jelly extraction, with seeds removed
3 cups sugar
½ cup grape juice

Press grape pulp through a coarse sieve to remove seeds and skins. Measure, add sugar and grape juice. Cook slowly until thick. Stir frequently to prevent burning. Pour into hot sterile glasses and seal with parraffin.

FIGURE 4.—Fruit and foliage of the common guava. *(Psidium guajava)* 3/8 natural size

COMMON GUAVA

(Psidium guajava)

Description: The guava is a medium-sized, round or oblong yellow fruit 1½ to 3 inches in diameter, with a thick, coarse, edible rind surrounding a mass of seeds imbedded in a firm, soft pulp. The flesh varies from white to yellow to red. Though the fruit may be either sweet or sour, it always has a distinctive, characteristic flavor.

History: Although Thrum's "Hawaiian Annual" *(65, p. 129)* states that the common lemon guava was brought to the Hawaiian Islands from Australia by G. Montgomery in 1851, some variety was undoubtedly growing in the Islands before that; for Reverend Sereno L. Bishop, who was born at Kailua, Hawaii, in 1824, states *(5)* that guavas were a choice fruit in the later 30's and did not become wild until 20 years later. At present the guava is the most common wild fruit in the Territory and is thoroughly naturalized. It grows well under conditions unfavorable for many plants and in some places has become a pest. The word "guava" comes from the Haitian name for the fruit, *guayaba (50, p. 274)*.

Nutritive value: Greater use than at present should be made of the guavas which grow wild in great abundance at the lower altitudes on all the Islands.

Compared with other fruits in this series whole guavas are a very good source of iron, a moderately good source of calcium and a fair source of phosphorus. The iron content of the seeded guavas (i.e., those with the seeds removed) is only about one-fifth that of the whole, showing that most of the iron is in the seeds.

Data in Tables 9 and 10 show that guavas are a poor source of vitamin G, a good source of vitamins A and B, and an excellent source of vitamin C. A watery extract of guavas, here called guava juice (page 36), was also found to be an excellent source of vitamin C. Guava juice loses little if any of its vitamin C when made into jelly.

Guava juice keeps well, as some of the guava juice fed to guinea pigs was preserved under sterile conditions in jars and bottles and showed no signs of deterioration after 3 or 4 months. Guava juice bottled in this way has been used successfully for artificially fed infants for a period of 6 months *(35)*. The experiment was carried out with the aid of the physicians and nurses at two of the baby health conferences in Honolulu, who cooperated with a University student in Home Economics. Ten babies from 4 to 6 weeks of age were first fed daily half a teaspoon of guava juice diluted with an equal quantity of water. The guava juice ration was increased to one teaspoon the second week of feeding. Then it was gradually increased until, at the age of 2 months, each baby received 1 tablespoon (3 teaspoons) of guava juice diluted with an equal quantity of water. From then on it was gradually increased until the fifth or sixth month, when each baby was fed 2 tablespoons of guava juice every day. All the babies thrived and were in fine condition at the end of the 6 months' period.

Guava juice may be used in the diet of children and adults to supply generous quantities of vitamin C.

Supply: Guavas are most plentiful from June to October, but small quantities may be obtained at other seasons. They are not to be found in the Honolulu markets at any time of the year, for no attempt is made to pick and offer them for sale.

Use: The common guava may be used as a fresh fruit, served with sugar, for dessert and shortcake or may be combined with citrus fruit and pineapple in cocktails and salads. Guava juice makes an excellent substitute for orange or tomato juice in child feeding and makes a pleasing addition to punch. The guava is most highly prized for jelly making because of its distinctive flavor and high pectin and acid content. It also may be used for butters, jams, marmalades and preserves. The pulp remaining after the juice has been extracted for jelly making may be used satisfactorily for guavalets, guava catsup, butter or jam. The type of confection called guava paste may be made by evaporating the strained guava pulp until it is very thick. This is sold commercially in many parts of the world.

Guava jelly

Choose half-ripe, sour guavas, wash, remove blossom end, and cut in quarters. Add ¾ pound or 1½ cups water to each pound of guavas. This amount of water should be sufficient to almost cover the guavas. Boil slowly until fruit is very soft. Strain through a flannel jelly bag or two thicknesses of a sugar or flour sack. Do not squeeze bag in extracting the juice. If desired, a second extraction of juice may be made from the same pulp by adding water and boiling again. The second extraction has almost as much pectin but not as much acid as the first. When jelly is being made a small amount of lemon juice may be added to increase acid.

The amount of acid and pectin present in guavas varies with maturity of the fruit and locality where it is grown. A test for pectin may be made by adding 1 tablespoon of wood or grain alcohol to 1 tablespoon of juice. If the mixture becomes thick and gelatinous, there is considerable pectin present, and 1¼ to 1 cup of sugar should be used for each cup of juice. For half-ripe guavas from Manoa Valley 1¼ or 1⅛ cups of sugar to 1 cup juice usually proves the best proportion for the first extraction juice.

Jelly should not be made in quantities larger than 4 cups at one time, as a dark gummy jelly will result from long cooking. Since a short cooking and rapid evaporation are desirable in jelly making, a shallow kettle with a capacity four times the measure of juice should be used.

Bring juice to the boiling point and if more than 2 cups are used, boil from 5 to 10 minutes before adding sugar. Remove scum which forms on top after sugar is added. Test jelly by allowing juice to drip from a spoon, removing kettle from fire while testing. When three or four drops run together and "sheet" off the spoon in one large drop, the jelly is done. It may also be tested with a thermometer—104° Centigrade, or 219° Fahrenheit, on a very clear day; 105° Centigrade, or 221° Fahrenheit, on a damp cloudy day; and 106° Centigrade, or 222° Fahrenheit, on a rainy day.

Pour jelly into hot sterile glasses and seal with paraffin. Pulp remaining after juice is extracted should be used for guava catsup, butter, jam or guavalets.

Guava juice
yield 1½ quarts

4 pounds or 48 to 50 medium sized, firm, ripe or half-ripe guavas
1 pound or 2 cups of water (sufficient to barely cover sliced guavas)

Wash, remove blossom end and cut guavas into slices. Add water, bring to boiling point quickly, and boil 15 minutes. Strain through a jelly bag. Heat juice to boiling, pour into hot sterile jars and seal or pour into bottles and cap with commercial capper immediately. This juice will keep indefinitely if canned or approximately a week in a refrigerator if not canned.

Because of its high vitamin C content it makes an excellent substitute for orange or tomato juice in child feeding (see page 34). Dilute with an equal quantity of water for a very young child and, if desired, sweeten with a very small quantity of sugar.

It may also be canned to use for fruit punch.

Guava syrup*
yield 2 quarts

4 cups guava juice
6 cups sugar
4 cups water

Prepare guava juice as directed in recipe for extraction of juice for jelly. Combine juice, water, sugar, and boil slowly for 30 minutes, or until proper consistency for syrup. Pour into hot sterile jars and seal. Serve on griddle cakes or as sauce for ice-cream and puddings.

Guava milk shake
yield 1 large glass

1 cup milk
1½ teaspoons sugar, if juice is used
1⅓ tablespoons guava syrup or 4 tablespoons guava juice

Combine ingredients, pour into a glass jar and cover with a tight fitting lid. Chill and shake ingredients thoroughly. Serve in a tall glass.

Guavalets*
yield 1¾ pounds

2 cups strained cooked guava pulp (Pulp left from jelly making may be used)
2 tablespoons cold water
½ cup chopped English walnuts
¼ tablespoon gelatin
3½ cups sugar

Cook pulp and sugar together until mixture is very thick and seems to leave the sides of the pan. Use a very low fire and stir mixture frequently to prevent burning. Soak gelatin in cold water for 5 minutes; melt over hot water and add to guava pulp. Remove from fire, cool, add nuts, and pour into a buttered shallow pan. When cold cut into 1-inch squares and wrap each piece in wax paper.

* Contributed by Agricultural Extension Service.

Guava butter

yield 1¼ quarts

8 cups cooked guava pulp (Pulp left from jelly making may be used)
6 cups sugar
3 tablespoons grated fresh ginger root
¾ teaspoon ground allspice
¾ teaspoon ground cinnamon
6 tablespoons lemon juice (2 lemons)

Press guava pulp through a sieve before measuring the quantity, add remaining ingredients, and cook slowly until thick. Stir frequently to prevent burning. Pour into hot sterile jars, cool, and cover with paraffin.

Guava catsup*

yield 2½ quarts

3 quarts guava pulp (This may be pulp left after extracting juice for jelly.)
5 medium sized onions, sliced fine
2 large cloves of garlic, sliced fine
5 small peppers, chopped fine (seeds removed) or ⅛ teaspoon of ground pepper
3 cups vinegar
4 teaspoons ground allspice
3 teaspoons ground cinnamon
2 teaspoons ground cloves
6 cups sugar
1 tablespoon salt
¼ cup water

Cook onion in the water until it is soft. Combine all the ingredients, cook for 30 to 40 minutes, pour into hot sterilized jars and seal immediately. This is excellent to serve with meat or avocados.

Guava papaya jam

yield 1½ quarts

4 cups cooked guava pulp
8 cups sugar
4 cups fresh papaya pulp
6 tablespoons lemon juice
grated rinds of 2 lemons

Combine fruit pulp and cook until most of the water has been evaporated. Add sugar and lemon. Cook until thick, pour into hot sterile jars, cool, and seal with paraffin.

Guava marmalade

yield 1½ to 2 pints

4 pounds whole ripe guavas (48–50 medium sized)
6 cups sugar
2 cups water
¼ cup lemon, sliced fine and cut in halves
1½ teaspoons grated green ginger root

Wash, remove blossom end and blemishes from guavas. Cut fruit in halves; remove soft inner pulp and seeds with a spoon and use this pulp for guava ice cream, mousse or cake icing. Cut guava shells in strips ⅛-inch wide, cover with sugar, add water, and allow to stand 3 to 4 hours. Add ginger root and lemon; boil until syrup is slightly thick, but not until it gives a jelly test. Pour into hot sterile jars and seal at once.

* Contributed by Agricultural Extension Service.

Fresh guava fruit punch

6 servings (1 cup)

- 1½ cups water
- ¾ cup sugar
- 3 cups medium strength tea
- 6 ripe guavas
- ¾ cup orange juice
- ¼ cup lemon juice
- ½ cup pineapple juice
- ½ finger of fresh ginger root

Peel ginger root and chop fine, boil with ½ cup of the water until a strong ginger flavor is obtained; cool and strain through a cloth, squeezing ginger root. Wash guavas, cut and press through a fine sieve to remove seeds. Combine all ingredients, stir until sugar is dissolved, and pour over cracked ice before serving.

Aloha punch

12 servings (1 cup)

- 2⅔ cups unsweetened guava juice
- 2⅔ cups orange juice
- 1⅓ cups lemon juice
- grated rinds of 1 orange and 1 lemon
- 4 cups water
- 1⅓ cups shredded pineapple
- 2 cups sugar
- few drops of red coloring

Boil sugar and water for 3 minutes. Cool, add fruit juice and pineapple, chill, and pour over cracked ice before serving.

Manoa fruit punch

100 servings (⅓ cup)

- 7 cups water
- 7 cups sugar
- 6 cups guava juice
- 9 cups fresh pineapple juice
- 1 fresh ginger root
- 10 cups orange juice (4 dozen small sized)
- 2 cups lemon juice (1 dozen)
- ½ cup finely chopped fresh mint leaves

Wash and peel ginger root, chop fine and boil with 3 cups of the water until a strong ginger flavor is obtained. Cool and strain through a cloth, squeezing the ginger root. Boil 4 cups of water and sugar together to make a syrup, then cool. Combine all ingredients and pour over cracked ice to chill. Dilute with cold water if punch is too strong when ready to serve.

Guava whip

6 servings

- ¾ cup sugar
- 1 tablespoon gelatin
- ¾ cup water
- 1 tablespoons lemon juice
- ¼ teaspoon salt
- 1 cup fresh guava pulp or cooked pulp remaining from jelly extraction
- 2 egg whites
- 1 cup fresh shredded coconut if desired

Soak gelatin in ¼ cup of the water. Add remaining water to sugar and heat to the boiling point, add gelatin and stir until dissolved. Press guava pulp through a sieve, add salt and lemon juice, and gradually beat in the cooled syrup. Set in a cool place, and when it begins to thicken fold in coconut and stiffly beaten egg whites. Pour into molds and chill before serving. Serve with shredded coconut, cream or whipped cream.

Guava ice box cake*

6 servings

⅔ cup fresh or cooked guava pulp (pressed through sieve before measuring)
⅓ cup shredded pineapple
2 tablespoons lemon juice
⅔ cup sugar
2 teaspoons gelatin
3 tablespoons cold water
3 tablespoons boiling water
2 beaten egg whites
8 lady-fingers
½ cup whipping cream

Soak gelatin in cold water a few minutes, add it and the sugar to boiling water, and stir until dissolved. Cool, add fruit pulp and juice, mix thoroughly, and place in refrigerator to congeal. When the mixture is partially congealed, beat until foamy and fold in beaten egg whites. Line a mold with halves of lady-fingers, pour in mixture and chill 4 to 6 hours. Turn out on large plate and garnish with whipped cream and guava jelly.

Guava icing

yield 1½ cups

½ cup fresh guava pulp
⅔ cup sugar
½ egg white
½ teaspoon vanilla

Combine ingredients in a mixing bowl. Beat with Dover egg beater for 20 minutes, or until proper consistency to spread on cake.

Guava sherbet

yield 1½ quarts

4½ cups unsweetened guava juice
2¼ cups sugar
4½ tablespoons lemon juice
¾ tablespoons gelatin
⅜ cup cold water
a few drops of red coloring

Combine guava juice and sugar and heat to the boiling point. Soak gelatin in water for 10 minutes and add to hot liquid. Stir until gelatin is dissolved, cool, add lemon juice and coloring matter. Freeze in an ice-cream freezer using 8 parts of ice to 1 part of ice-cream salt.

Guava ice cream

yield 1½ quarts

2½ cups fresh guava pulp
1 cup fresh whole milk or thin cream
1 cup evaporated milk
2 cups sugar
2 tablespoons lemon juice

Press the guava pulp through a sieve and add lemon juice. Combine the fresh milk or cream with the evaporated milk, add the sugar and stir until it is dissolved. Combine with other ingredients and freeze, using 8 parts of ice to 1 part of ice-cream salt.

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* From The Goodly Guava—Isabelle S. Thursby, Bull. 70, Agricultural Extension Service, Tallahassee, Florida.

Guava mousse
6–8 servings

1 cup fresh guava pulp	¾ cup sugar
1 tablespoon lemon juice	2½ cups whipping cream or 1⅔ cups evaporated milk

Wash, cut guavas, and remove inner pulp with a spoon. Press pulp through a sieve to remove seeds, add sugar and lemon juice to pulp, and fold into whipped cream. Evaporated milk is prepared for whipping by heating the can in simmering water for 20 minutes, then chilling thoroughly. Whip until it thickens. Pour guava mixture into mechanical refrigerator pan and freeze 4 to 6 hours, or into well sealed mold packed in 3 parts of ice to 1 part of ice-cream salt.

STRAWBERRY GUAVA

(Psidium cattleianum)

Description: This is a small, round fruit, 1 to 1½ inches in diameter. The delicate, easily bruised skin is a deep purplish-red. The center of the fruit is filled with a very juicy pinkish-white pulp and numerous small hard seeds. Because the juice produces a deep brown stain difficult to remove, care should be used in handling the fruit. The flavor is sweet and agreeable but rather acid.

History: The strawberry guava, as it is commonly called because of its supposed resemblance to the strawberry in flavor, is a native of Brazil *(50, p. 280),* and from there was carried to all parts of the world. The history of its introduction into Hawaii is not known. The tree is grown in private gardens, often only as an ornamental shrub.

Nutritive value: In comparison with the common guava, the fruit contains about twice as much calcium and about the same quantity of phosphorus. The calcium content is exceeded only by tamarinds and oranges with membrane.

No tests to determine the vitamin content of strawberry guavas have been made but their vitamin value is probably similar to the common guavas.

Supply: The fruit ripens at intervals from May to November but it is rarely found in the open markets.

Use: The strawberry guava is sweeter and has a more delicate flavor than the common guava. It is very delightful eaten fresh, and the juice of the ripe or half-ripe fruit makes a pleasing acid drink or, combined with the juice of pineapple or other citrus fruits, makes a delectable punch. Strawberry guavas are not extensively used for jelly, but if a few are added to the half-ripe common guava a very attractive pink colored jelly is obtained. The strawberry guavas are so small that the removal of the seeds to prepare them for marmalade or preserves is laborious.

FIGURE 5.—Fruit, foliage and cross section of the strawberry guava. *(Psidium cattleianum)* 3/8 natural size

Half-ripe strawberry guava-ade

6 servings

3¾ cups half-ripe strawberry guava juice
2 cups water
1⅛ cups sugar

Prepare juice as directed for making guava jelly. Mix ingredients and pour over cracked ice.

Ripe strawberry guava-ade

6 servings

6 cups ripe strawberry guava juice
1½ cups sugar

Prepare juice as directed for making guava jelly. Mix ingredients, pour over cracked ice, and serve.

Half-ripe strawberry guava punch

6 servings

3 cups half-ripe strawberry guava juice
2 cups orange juice
1½ cups sugar
⅔ cup lemon juice

Prepare juice as directed for making guava jelly. Mix ingredients, stir until sugar is dissolved, and pour over cracked ice.

LEMON

(Citrus limonia)

Description: Several varieties of lemons are grown in Hawaii, some of which vary greatly in size and appearance from the well-known commercial lemon. One of the larger varieties is 4 to 6 inches in length with a thick, warty, greenish-yellow rind. The flavor of the fruit is strongly acid but pleasant. The common, commercial varieties are grown only to a limited extent.

History: The lemon is a native of southern Asia but is now grown in many warm sections of the world. Lemon plants are said to have been first introduced into Hawaii early in the 19th century *(49, p. 32)*.

Nutritive Value: The small quantities of lemons and limes used in the average diet make their nutritive value of minor importance. Both yield an alkaline ash in the body because their high acidity is due to citric acid and basic salts of citric acid. Both fruits are good anti-scorbutics but lemons are superior to limes.

Supply: The season is the same as that of oranges, October, November and December, although they are produced in small quantities during most of the year. There is usually a period of one or two months in the spring when they are not obtainable.

Use: The juice of the lemon makes a very refreshing iced drink, used alone or in combination with other fruit juice. It is combined with or served with a great many other foods in order to improve their flavor.

ACID LIME

(Citrus aurantifolia)

Description: The acid lime is a small citrus fruit of characteristic flavor. Several varieties are grown successfully in Hawaii. The common type of lime is a small, round or oval fruit about 1½ to 2¼ inches in diameter. The color of the thin skin is light yellow shading to green. The flesh is yellow-green and very juicy, containing large quantities of citric acid.

History: Like the lemon, the acid lime is a native of southern Asia from where it has spread to many tropical and sub-tropical sections of the world. The lime has flourished in Hawaii since its introduction during the early part of the 19th century and seems the most adaptable of the citrus fruits to island conditions *(43)*.

Nutritive Value: See Lemon.

Supply: Limes are in season practically the entire year, the heaviest crop coming in the late summer and fall. The price varies with the quality and supply. The supply usually equals the demand.

Use: Lime juice is very refreshing and makes a pleasant addition to iced drinks or punch. Lime syrup may be prepared and kept on hand for future use. Lime juice may be substituted for lemon in any recipe. Two-thirds as much lime juice should be used because of its higher acidity.

Fresh limeade
6 servings

7 tablespoons lime juice (9 limes)	1⅓ cups sugar
	5¼ cups water

Make a syrup by boiling the sugar with 1 cup of water. Cool, and add the lime juice and remaining water. Serve with cracked ice.

Lime syrup
yield 2½ cups

1 cup lime juice (2 dozen small limes)	2 cups sugar
	½ cup water

Wash limes, dry, and squeeze the juice. Make a syrup of the sugar and water by boiling 10 minutes. Add lime juice, pour into hot sterile jars, and seal immediately.

Dilute for limeade by using 2 tablespoons of syrup to 1 cup of water, and serve with cracked ice.

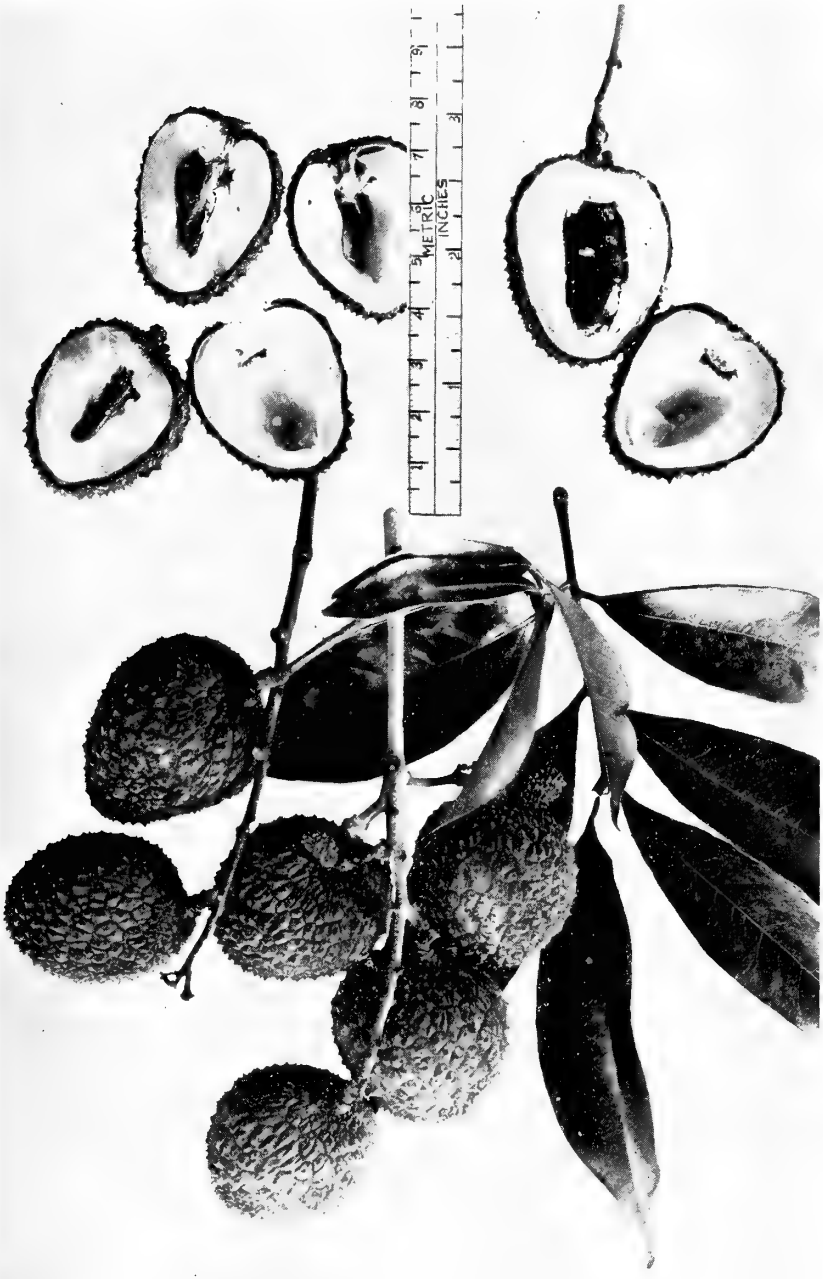

FIGURE 6.—Fruit, foliage and cross section of litchi. *(Litchi chinensis)* ¾ natural size

LITCHI

(Litchi chinensis)

Description: The litchi is a small, oval or ovate fruit about 1½ inches in diameter. In most varieties, the outer shell-like covering is red and the flesh surrounding the single brown seed is white. The seed varies considerably in size with different varieties and seedless fruits have been grown. The fruit is produced in clusters of 3 to 20 or more and is marketed in clusters. The flavor of the fresh litchi is sweet and slightly acid, reminding many people of that of the Muscat grape. (The dried fruits, known as "litchi nuts," are very different from the fresh and bear somewhat the same relation to them as raisins do to fresh grapes.)

History: The litchi is a native of South China *(19, p. 4),* where it has been cultivated for many centuries and from there has spread gradually to many other tropical and sub-tropical countries. The first litchi tree to be brought into Hawaii is believed to have been planted on the property of Mr. C. Afong in 1873 and has usually borne abundantly *(19, p. 5)*. Within recent years, many other trees have come into bearing throughout the Territory.

Nutritive value: Of the two varieties of fresh litchis analyzed in this series, the Kwai Mi has nearly twice the sugar content (20.6 percent) of the Hei Yeh variety which has 11.8 percent of sugar. The Kwai Mi, though a smaller fruit with a larger percentage of refuse, is considered to be of superior flavor and quality.

Both varieties are very poor sources of calcium, good sources of phosphorus and fair sources of iron.

No vitamin tests were made at the station laboratory and none are reported in the literature.

Supply: The season for the litchi is a short one, usually during June and the early part of July. Small quantities of litchis reach the Honolulu markets, Chinese stores and fancy grocers. The supply on the retail market never meets the demand so that they command a high price per pound.

Use: The litchi is a delicious fruit highly prized by the Orientals, the canned fruit as well as the dried being imported from China. Litchis are most frequently served fresh, eaten out of the shell, but shelled fresh litchis make a pleasing addition to a fruit cocktail or fruit salad. The fruit may be successfully canned at home in a medium syrup with the addition of lemon or lime juice to improve the flavor. Canned litchis may be served as a dessert, added to fruit combinations or cocktail and salad, or may be used in a sauce served with fried fish or shellfish, Chinese style.

Canned litchis
Open kettle method

Wash, peel litchis, and carefully remove the seeds, leaving the fruit whole if possible. Add sugar in the proportion of 1 cup of sugar to 3 cups of litchis. Heat to boiling and boil gently 7 minutes or until tender. Fill hot sterile jars with the boiling fruit and juice and seal immediately. Label and store in a cool, dark place.

Canned litchis
Pressure cooker method

Wash, peel litchis, and carefully remove the seed.

Prepare a medium syrup using 1 cup of sugar to 2 cups of water.

Heat fruit to the boiling point, boil 2 minutes, pack into hot sterile jars and fill to the top with the boiling syrup. Seal jars and process in a pressure cooker 7 minutes at 5 pounds pressure. Cool, label, and store in a cool, dark place.

Litchi, pineapple and orange cocktail
6 servings

2 cups seeded fresh litchis, cut into halves or quarters
2 cups diced fresh pineapple
2 cups diced orange sections
2 tablespoons sugar
1 tablespoon lemon juice

Prepare the fruit by cutting in pieces of similar size and saving the juice from each. Add the sugar and lemon juice to the other fruit juice, pour over the diced fruit and chill for one hour before serving.

This fruit mixture may be used for a salad if the drained fruit is chilled and combined with the sugar and lemon juice shortly before serving on lettuce leaves. Serve with ⅓ cup mayonnaise or French dressing.

Litchi, papaya and pineapple salad
6 servings

2 cups seeded fresh litchis, cut into halves
2 cups diced papaya
⅓ cup mayonnaise
2 cups diced fresh pineapple
2 teaspoons lemon juice

Combine the fruit, add the lemon juice and chill thoroughly. Add the mayonnaise, mix and serve on lettuce leaves.

Litchi and cottage cheese salad
6 servings

36 large seeded litchis
¾ cup cottage cheese
½ cup mayonnaise
⅓ cup shelled pecans

In shelling and removing the seeds from the litchis, the fruit should be loosened from the seed at the stem end and cut lengthwise in order to remove the seed and leave the fruit as nearly whole as possible.

Stuff the cavity with cottage cheese, chill and place on lettuce leaves. Garnish with mayonnaise and pecans.

FIGURE 7.—Fruit, foliage and seed of the Pirie mango. *(Mangifera indica)* Natural size

MANGO

(Mangifera indica)

Description: Many recognized varieties of mangos as well as unnamed hybrids are grown in Hawaii. In general, the mango can be described as a medium-sized fruit from 2 to 4 inches in width and from 3 to 7 inches in length. The skin, which is smooth and thick, is strong enough to be pulled from the flesh when the fruit is ripe or nearly so. As the fruit matures the green skin changes in most varieties to more brilliant colors which may be purplish-red shading to green, deep crimson, or even yellow with red spots. The flesh varies in color from light lemon to deep apricot. In the most prized varieties, it is juicy, smooth, free from fiber, and it separates easily from the large hairy seed. The flavor, which varies greatly, may be insipid and sweet or reminiscent of turpentine; however, in good varieties it is very delicious, reminding many people of the flavor of the peach.

History: Although the mango is now grown in many sub-tropical sections of the world, it is indigenous to Southern Asia *(50, p. 79)*. T. G. Thrum *(65, p. 129)* states that the first mango trees were brought to Hawaii from Manila in 1824 by Captain John Meek of the brig "Kamehameha." The small trees were divided between Reverend Joseph Goodrich and Don Marin. These trees were the source of the mangos known as the Hawaiian race. Joseph Marsden in 1885 imported from Jamaica several seedling mango trees, including the famous No. 9 which is still growing in the grounds of the government nursery on King Street. G. P. Wilder and S. M. Damon also brought in several good varieties; and the Hawaii Agricultural Experiment Station, through the U. S. Department of Agriculture, Bureau of Plant Industry, introduced a number of varieties from foreign countries *(46)*. Additional information about the mango may be obtained from a previous bulletin of the Hawaii Experiment Station *(46)*.

Nutritive value: Mangos have a high sugar content, but are a poor source of calcium, phosphorus and iron.

One variety of Indian mangos tested by Crawford and Perry in England *(8)* showed a high vitamin A content, approximately that of good butter; and two other varieties showed about half the value of the first. The authors do not mention whether there appeared to be any difference in the color of the mangos tested, but the vitamin A value is doubtless due to the yellow pigments.

Experiments of Guha and Chakravorty *(16)* in India indicate that mangos are a fair source of vitamin B and a good source of vitamin G (B_2). The vitamin C content seems to vary considerably, for the English authors *(8)* found that one variety was particularly high in vitamin C (twice that of lemon), that two other varieties were less potent, and that one variety showed no vitamin C. The Indian authors also report a low vitamin C potency for the variety which they tested.

No vitamin tests on local mangos have been made.

Supply: In comparison with the quantity grown, very few mangos reach the commercial market, usually only those of high quality, such as Pirie or Victoria. Because the supply is never equal to the demand, they command a high price. The roadside vendors sell a fairly large quantity, not always of the best variety. The mangos usually begin to ripen in April and are available until November.

Use: The mango is most desirable used fresh as a dessert fruit or in combination with citrus fruits, pineapple or papaya. It is delicious in cocktails, salads, shortcake and frozen desserts. Many people prefer the flavor of the green or half-ripe mangos, which may be used in pies or cooked and served as a sauce. Many children eat them when they are green, hard and very sour. The season is comparatively short, but mango slices or the sauce may be satisfactorily canned for future use. Mango chutney is the favorite way of preserving, although mangos make delicious jams and marmalades.

Canned mangos—open kettle method

yield 2 quarts

8 cups peeled, firm, ripe mango slices
6 cups sugar
4 cups water
¼ cup lemon juice

Combine sugar and water and heat to boiling point. Add mango slices; cook 10 minutes or until clear, add lemon juice, and pour into hot sterile jars, fill with syrup, and seal. Label and store in cool place. This syrup seemed very sweet at the time of canning, but on standing several weeks the product was found to be more satisfactory than if a thinner syrup was used.

Canned mangos—cold pack method*

yield 2 quarts

8 cups peeled, firm, ripe mango slices
4 cups sugar
4 cups water

Make a syrup of sugar and water by heating to boiling point. Add mango slices and cook 10 minutes, removing scum from the top. Allow fruit to stand until it looks clear, then reheat to boiling, pack in hot sterile jars, seal, and process in water bath 15 minutes. If pressure cooker is to be used, pre-cooking is not necessary. Pack uncooked mango slices in hot sterile jars and pour the boiling syrup over them. Partially seal and process in pressure cooker 15 minutes at 5 pounds pressure. Remove, seal and invert to cool. Label and store in cool place.

Mangoade

6 servings

1½ cups ripe mango pulp pressed through sieve
1 cup orange juice
½ cup lemon juice
⅓ cup sugar
3 cups water
grated rind ¼ orange

Combine sugar, water, and orange rind and bring to boiling point. Cool, add to mango pulp and fruit juice. Chill and pour over cracked ice before serving.

* Contributed by Agricultural Extension Service.

Mango sauce

yield 1 quart

6 cups green or half-ripe mango slices
1½ cups to 2 cups sugar
1½ cups water

Cook mangos in water until they are soft. Add sugar and cook 5 minutes longer. Serve with meat or as a dessert. This may be used for a shortcake filling or in sherbets, ice creams, or mousses.

Canned mango sauce

Sweetened or unsweetened sauce made from the green or half-ripe mangos may be canned for future use as a sauce or for sherbet, shortcake, or mousse. Pack hot sterile jars with the boiling hot sauce, seal, and process in hot water bath for 30 minutes or in pressure cooker for 10 minutes at 5 pounds pressure.

Mango jam

yield 1 quart

12 cups half-ripe or ripe mango slices
6 cups sugar
4 cups water

Cook mango slices with water about 15 minutes or until tender. Press through a sieve, add sugar, and boil until thick and of proper consistency for a jam. Pour into hot sterile jars and seal with paraffin.

Mango papaya jam

yield 2 quarts

8 cups peeled mango slices
5 cups water
8 cups papaya slices
8 cups sugar

Cook mango slices in 2½ cups water until tender and press through a coarse strainer. Cook papaya in remaining water until soft. Combine papaya and mango, add sugar, and cook slowly for 1 hour, or until of proper consistency for jam. Pack in hot sterile jars and seal with paraffin.

Mango butter

yield 2 quarts

12 cups peeled half-ripe mango slices
6 cups sugar
4 cups water
½ teaspoon ground cloves
½ teaspoon ground allspice
1 teaspoon ground cinnamon
1 teaspoon ground nutmeg

Add water to mangos and cook until soft enough to mash. Press through a sieve if mangos are stringy. Add sugar and spices, and cook slowly for 45 minutes, or until thick. Stir frequently to prevent burning. Pour into hot sterile glasses and seal with paraffin.

Mango chutney
yield 2 quarts

12 cups mango slices
4 cups vinegar
½ cup chopped green ginger root
4 chili peppers, with seeds removed, (chopped fine)
1 clove of garlic
6 cups sugar
3 cups seedless raisins
1 large onion sliced
1 teaspoon salt

Boil vinegar and sugar 5 minutes, add mangos and other ingredients, and cook about 1 hour until thick and of the desired consistency. Pour into hot sterile glasses and seal immediately.

Mango chutney
yield 6 quarts

10 pounds peeled sliced mangos
5 pounds sugar
6 or 7 cups vinegar (depending on acidity of mangos)
¾ cup salt
1½ pounds almonds, blanched and cut in thin strips
1 pound finely sliced candied orange peel
1 pound finely sliced candied lemon peel
2 large onions, chopped fine
2 pounds seedless raisins
1 pound finely sliced citron
⅔ cup green ginger root, cooked and chopped fine
1 cup finely chopped preserved ginger
2 cloves of garlic, chopped fine
8 small red peppers with seeds removed, chopped fine

Cut mangos, sprinkle with salt and allow to stand over-night. Boil the sugar and vinegar 5 minutes. Add to the drained mango pulp, cook until tender; then add the other ingredients and cook slowly for ½ to 1 hour or until the desired consistency is obtained. Pour into hot sterile jars and seal immediately. Serve with meat or curried dishes.

Mango pickle
yield 1½ quarts

9 cups green mango slices
6 cups salt water (1 tablespoon salt to 1 cup water)
9 cups sugar
4½ cups vinegar
½ tablespoon whole cloves
½ tablespoon whole pepper-corns
4 bay leaves
4½ cups water

Soak mangos over-night in sufficient salt water to cover. Drain, add the fresh water and cook until partially tender, about 30 minutes; add spices and vinegar, cook about 15 minutes longer, or until mango slices are tender. Drain mangos and cook syrup until it is slightly thick. Add mangos, heat to boiling point, and pack in hot sterile jars. Seal immediately, label, and store in cool place.

Baked custard with sliced mango

6 servings

2 cups milk
2 eggs
¼ cup sugar
¼ teaspoon vanilla
1 cup sliced ripe mangos
⅛ teaspoon salt

Heat milk to the simmering point, add sugar and salt. Beat eggs just enough to mix well and slowly add to hot milk. Place mango slices in bottom of custard cups or baking dish; pour custard over this, set dishes in pan of water, and bake in a slow oven (300° F) for 1 hour. To test insert a knife blade, and if it comes out clean remove custard from oven. Cool and serve.

Mango brown betty

6 servings

2 cups half-ripe mango slices, firmly packed in cup
¾ cup brown sugar
3 tablespsoons butter
⅔ cup bread crumbs
1 teaspoon cinnamon
3 tablespoons water unless mangos are very watery

Melt fat, add bread crumbs. Place a layer of the buttered bread crumbs in an oiled baking dish. Add a layer of mangos, sprinkle with sugar and cinnamon, add another layer of crumbs, then mangos, and then crumbs on top. Bake in moderate oven (350° F) until mangos are soft, about 1 hour.

Mango papaya pie

4–6 servings

1 cup cooked ripe papaya pulp
1 cup cooked half-ripe mango pulp
1 cup sugar
1 egg yolk
1 teaspoon cinnamon
¼ teaspoon nutmeg
2 egg whites
2 tablespoons sugar

Mash cooked fruit or press through sieve. Add egg yolk, spices and sugar. Cook slowly until the mixture thickens. Cool, pour into baked pie shell, and cover with meringue made of stiffly beaten egg whites and the 2 tablespoons sugar. Brown in slow oven (300°–325° F) for 20 minutes.

Mango pie

4–6 servings

3½ cups peeled half-ripe mango slices
1 cup sugar
½ teaspoon ground cinnamon
¼ teaspoon ground nutmeg
1 tablespoon lemon juice
2 tablespoons water
2 to 3 tablespoons flour

Parboil mango slices in water for 5 minutes. Line a pie pan with pastry, put in a layer of mango slices, sprinkle with sugar, flour and spices, and cover with another layer of mangos, sugar, flour and spices. Cover with pastry and bake in hot oven (425° F) for 10 minutes, then bake from 30 to 40 minutes in moderate oven (350° F) until mango slices are soft.

One cup ripe papaya slices may be substituted for 1 cup of the mangos if desired. The quantity of lemon juice should be doubled if papaya is used.

Mango sherbet

yield 1½ quarts

2 cups thick unsweetened green mango sauce
⅓ to ½ cup lemon juice
2½ cups sugar
¾ cup water
1 egg white
3 cups milk

Dissolve sugar in water by bringing to the boiling point, cool, add to fruit and milk. Add unbeaten egg white, pour into freezing container, and freeze using 8 parts of ice to 1 part of ice-cream salt. The mixture may curdle but this does not affect the finished product.

Mango-papaya mousse

6 servings

1 cup ripe papaya pulp
1 cup half-ripe mango pulp
6 tablespoons sugar
2 tablespoons lemon juice
½ cup evaporated milk or whipping cream

Peel papaya and mangos and press through a sieve. Add the sugar and one half the lemon juice, and set aside until the sugar is dissolved. Simmer milk in the can for 20 minutes, then chill thoroughly, whip until thick, add remainder of lemon juice, and whip until very stiff. If whipping cream is used, chill it thoroughly and whip until stiff. Fold in the mango-papaya mixture. Pour into refrigerator pan and freeze 4 to 6 hours or into well-sealed mold packed in 3 parts of ice and 1 part of ice-cream salt. Seal mold with a strip of cloth dipped in hot paraffin or fat.

Mango mousse for mechanical refrigerator

6 servings

12 marshmallows
¾ cup unsweetened half-ripe mango sauce
1 cup whipping cream
⅓ cup water
¾ cup sugar

Dissolve marshmallows in water by heating slowly until a smooth liquid is obtained. Cool and add mango sauce. Chill and whip cream. After mango-marshallow mixture has started to congeal, add whipped cream and mix thoroughly. Freeze in mechanical refrigerator pan.

MOUNTAIN APPLE (Malay-apple)

(Eugenia malaccensis)

Description: The mountain apple is an oval fruit from 2 to 3 inches long with a very thin crimson skin shading to pink or white. The crisp, white flesh is juicy and of pleasant, though not distinctive, flavor. Each fruit contains one or two large brown seeds. The fruit is very easily bruised and stains the hands deep purple.

History: This fruit, a native of the Malayan Archipelago, was brought to Hawaii by the primitive Hawaiians *(50, p. 308)* and has flourished in the deep mountain valleys of all the islands.

Nutritive Value: Mountain apples are a poor source of all nutrients, including calcium and phosphorus and a fair source of iron. They are only a fair to poor source of vitamins A, B, C, and G (B_2) *(36)*.

Supply: The season ranges from June to December. The fruit is brought down from the mountains and sold along the roadside, but it does not reach the city markets in large quantities.

Use: The mountain apple is very refreshing to eat because of the large amount of water present and the delicate flavor. It is most frequently eaten out of the hand, but may be cut up and used in salads and cocktails. There is not enough pectin or flavor to make it desirable for jelly or preserves.

HAWAIIAN ORANGE

(Citrus sinensis)

Description: Although several varieties of oranges have been introduced into Hawaii, only the seedling known as the Hawaiian is grown commercially. The Hawaiian orange is a medium-sized, round variety. The yellow skin is thin and rather tough. The flesh is commonly yellow-orange and very juicy. It varies from acid to sweet but is usually rather mild in flavor. Additional information about the orange and other citrus fruits may be obtained from a previous bulletin of the Hawaii Experiment Station *(49)*.

History: The Hawaiian variety of orange has been developed by a long period of cultivation in these islands. One of the original orange trees left in Hawaii by Captain Vancouver in 1792 still lives. He gave the natives a number of small orange seedlings *(69)*, some of which were planted on a piece of land belonging to a prominent Hawaiian at Kealakekua in the District of Kona. In time, the land came into the possession of the famous high chiefess, Kapiolani, and later was obtained by an early missionary, the Reverend J. D. Paris, who began his residence there about 1852, at which time his daughter, Miss Ella Paris, was four years old. She still occupies a part of the old Paris home and clearly recalls that the old tree is one of several which were very old trees when she was a little girl.

The orange was one of the first fruits to be cultivated commercially in Hawaii, and at one time was the leading export from the district of Kona on the Island of Hawaii *(55)*. The districts of Waialua, on Oahu, and Waimea, on Kauai, were also well-known for their oranges; consequently in different sections of the islands this variety is known as the "Kona," "Waialua," or "Waimea" orange *(49, p. 19)*.

Nutritive value: The nutritive value of oranges has been extolled by so many scientists in recent years that little need be added here.

Oranges are a fruit of excellent flavor of which people rarely tire. Though acid to the taste they leave an alkaline ash residue in the body and tend, like most other fruits, to make the urine more alkaline.

The analyses in Tables 2 and 3 show Hawaiian oranges to have a chemical composition similar to that of oranges grown on the mainland. Average analyses *(59, p. 558)* show oranges to be superior to most fruits as sources of calcium and equal to or better than other fruits as sources of phosphorus and iron. Our analyses show that the calcium content of the orange with the membrane surrounding the sections, is almost twice that of the orange with the membrane removed, but the phosphorus and iron content is about the same in each case.

Our figure of 0.013 per cent of calcium for the Hawaiian orange juice, although about 30 per cent lower than Sherman's most recently published figure of 0.019 per cent *(60, p. 625)*, is less than half of his previously published figure of 0.029 per cent *(59, p. 558)*. A second sample of Hawaiian orange juice showed a calcium content of 0.010 per cent and a California navel orange juice prepared and analyzed in

like manner yielded a value of 0.015 per cent calcium. The juice for analysis was passed through a copper sieve of 10 mesh to the inch, a size comparable to household orange juice strainers on the market.

A personal communication from C. Chatfield of the food composition section of the Bureau of Home Economics, U.S.D.A., states that reports filed in their office indicate that the calcium content of oranges and orange juice varies greatly.

It is highly probable that the calcium content of oranges and orange juice may be affected by a number of factors such as variety, soil and fertilizer. Our analyses would indicate that the quantity of membranous material included in the juice is also an important factor.

Oranges are a fair source of vitamins A, B, and G and an excellent source of vitamin C. Hawaiian oranges have not been tested for their vitamin A, B, and G content; but results of experiments summarized in Tables 10 and 14 show that they are excellent sources of vitamin C.

Our tests were made over a short period when the local oranges were available so that we found no differences in the vitamin C values. However, Nelson and Mottern *(41)* have reported variations in the vitamin C content of fresh oranges and we have some evidence of variations in the vitamin C content of guavas.

Juice made from Hawaiian oranges, like that made from oranges grown elsewhere, develops a bitter flavor on standing a few hours. The cause of this bitter taste has been investigated by Traub and co-workers *(67)* in Florida. As the result of extended experiments, they concluded that the bitter taste which develops in prepared citrus juices is due to the glucosides contained in certain portions of the fruit, especially the white inner peel and the membranes surrounding the sections. They also concluded that enzymes of the fruit were not concerned in the development of the bitter flavor. Their experiments showed that the bitter flavor of the juices tended to decrease with the maturity of the fruit used, which they state is in harmony with the fact that the glucoside content of citrus fruits decreases with maturity.

Hawaiian oranges are commonly used with little or no previous storage, a practice which accounts in part for the fact that juice from some Hawaiian oranges seems to develop more bitter flavor than oranges from the mainland. We have also found that the juice from some varieties of oranges grown in Hawaii develops a bitter taste much more quickly than others. Juice from some Hawaiian seedlings had a slightly bitter taste half an hour after extraction by the usual household methods and a decidedly bitter taste after 1 hour. On the other hand, juice from Navel oranges grown at the Station showed no bitter flavor after almost 2 hours.

Supply: The oranges, grown principally in the Kona region on Hawaii, have not previously been in great demand because of the quality and appearance, very little grading being done for market. Plans are being perfected (1935) to improve the marketing of Hawaiian oranges by sorting them to conform to standard sizes and grades, and by ripening with ethylene gas, a practice used on the mainland for many years. The supply of first quality oranges is less than the demand. They are in season during October, November and December.

Use: The well-ripened and mature Hawaiian orange may be used in the usual ways. Because of the very bitter flavor of the membrane and inner pulp of the peel, it is difficult to make a palatable marmalade from them. Soaking the sliced orange and peel in water and discarding the water several times removes the bitterness sufficiently to make a desirable product. This process reduces the pectin content and flavor so that the addition of some orange and lemon juice at the time of final cooking is desirable. Juice made from the Hawaiian oranges should be used immediately and not allowed to stand.

Several years ago for three consecutive years, Dr. F. G. Krauss, director of the Agricultural Extension Service in Hawaii, and his daughter, Miss Beatrice Krauss, assistant plant physiologist of the Experiment Station of the Pineapple Producers Cooperative Association, compared the yield of juice from Hawaiian and California oranges. Using hundreds of oranges, they found the percentage yield of juice from Hawaiian oranges grown in Kona to be equal to or greater than that from California oranges bought on the open market *(27)*.

Tart orange marmalade
yield 1¼ quarts

2 Hawaiian oranges	3 cups water to 1 cup fruit
2 Hawaiian lemons	1 cup sugar to 1 cup fruit and water

Remove rind and soak it overnight. Discard water next morning and cook rind in a large quantity of water 30 minutes. Cool and scrape out white pulp. Cut peeling into very fine strips. Cut fruit into fine pieces, add 3 times as much water as the measure of fruit pulp. Allow to stand overnight. Add cooked peeling, as much sugar as measure of fruit pulp and water, and cook mixture until it gives a slight jelly test. Pour into hot sterile glasses and seal with paraffin.

Tart amber marmalade
yield 1½ quarts

2 Hawaiian oranges	½ cup lemon juice
2 Hawaiian lemons	¾ cup sugar to 1 cup fruit pulp and liquid
½ grapefruit or pomelo	
1 cup orange juice	6 cups water

Remove peeling from fruit and scrape out white pulp from it. Cut peeling into very fine strips. Cut fruit pulp into very fine pieces; add peeling and 2 cups of water. Let this stand over-night. Discard water and add 2 cups of fresh water, letting it stand over-night again. On the third day discard the water, replacing it with 2 cups of fresh water; cook for ½ hour. Add fruit juice and measure; then add ¾ cup sugar to each cup of fruit and liquid combined and cook until it gives a slight jelly test. Pour into hot sterile jars and seal with paraffin.

FIGURE 8.—Fruit and cross section of the papaya. (*Carica papaya*) ½ natural size

PAPAYA

(Carica papaya)

Description: The papaya is a melon-like fruit which varies greatly in size and shape. One strain known as the solo papaya is a small fruit only 4 to 5 inches in diameter, but papayas 20 inches or more in length and weighing 10 pounds may sometimes be seen on the market. They are often obscurely five-angled in transverse section.

The skin is smooth and thin, shading from deep orange to green. The flesh varies from 1 to 2 inches in thickness and from light yellow to deep salmon pink in color. Numerous round, black, wrinkled seeds, each enclosed in a gelatinous membrane, cling to the inner wall. The flavor and odor of the fruit are distinctive.

History: The date of the introduction of the papaya into Hawaii has been a matter of discussion for many years. Because the papaya has a distinctly Hawaiian name, *he-i,* some people insist that it grew in Hawaii before the first European voyagers arrived. However, Dr. Mayen, who visited Hawaii in 1831, states in the history of his trip, which was abstracted by Bishop Henry Restarick *(54),* that while visiting Don Marin's possessions he learned of the many kinds of plants introduce by Don Marin, among which was the papaya from the Marqueses. This introduction must have been prior to 1823, as William Ellis noted "pawpaw apples" growing in the gardens in Kona that year while on a trip through Hawaii *(48, p. 2).*

Pawpaw is the name commonly used in England for the papaya, but in the Southern United States, it is apt to be confused with pawpaw as applied to the *Asimina tribola,* a very different fruit. Most countries now use either the name papaya or some variation of it, as papaia, apaeya or papaja, which are all believed to be derived from the Carib word *ababai (50, p. 228).*

Additional information about the papaya may be obtained from a previous bulletin of the Hawaii Experiment Station. *(48)*

Nutritive value: The quantity of papain, a protein-splitting enzyme, consumed when even large quantities of papaya are eaten is probably not of any great nutritional significance, but it may possibly be the reason that a few people experience some digestive distress after eating papaya. (A note in *Science,* Dec. 13, 1935, states, however, that *ripe* papaya contains little or no papain.)

As an economical and important source of vitamins A and C and of calcium and a basic ash, papaya should be more widely used by people in Hawaii.

Carotene is the pigment in fruits and vegetables to which the vitamin A activity is commonly attributed, but in 1933 Yamamoto and Tin *(75)* pointed out that papaya contains no carotene but a pigment which they called caricaxanthin and which, like carotene, possesses growth promoting properties. Karrer and Schlientz *(25)* have confirmed the presence of caricaxanthin, but pointed out that it is chemically identical to cryptoxanthin.

Supply: Papayas are on the market during the entire year, the supply and quality varying greatly. The quality and flavor of papayas depend partially on the season and the amount of rainfall. The supply is greater than the demand during May, June and July.

Use: The papaya may be used green or ripe. The green papaya may be baked or boiled and served as a vegetable, or stewed and served as a sauce. In the ripe state it is more desirable used fresh, making an excellent breakfast or dessert fruit served with lemon or lime. In cocktails or salads it is usually combined with pineapple or the citrus fruits. The fresh papaya pulp with milk or cream makes a delicious frozen dessert. Cooking causes papaya to lose its distinctive flavor, but it is very palatable when made into jams and pickles.

Papaya catsup
yield 2 quarts

14 cups strained papaya pulp
4 tablespoons whole allspice
3 tablespoons whole cloves
3 tablespoons mustard seed
1 stick cinnamon
1 medium sized piece of ginger root, chopped
1 large onion, sliced
⅛ teaspoon red pepper
6 tablespoons sugar
2 tablespoons salt
1⅓ cups of vinegar
¼ teaspoon tartaric acid

Tie the spices and onion in a cheesecloth bag, add to the papaya pulp and cook slowly for 40 minutes. Add the sugar, salt, vinegar and tartaric acid crystals, cook 1 hour, or until thick. Remove bag of spices, pour catsup into hot sterile jars, and seal.

Ripe papaya jam
yield 1½ quarts

6 cups ripe papaya pulp
1 cup lemon juice
6 cups sugar

Press papaya through a coarse sieve before measuring, add lemon juice and sugar; boil vigorously for 20 minutes, or until thick enough for jam. Stir frequently in order to prevent scorching. Pour into sterile jars and seal with paraffin.

Papaya marmalade
yield 1¾ quarts

10 cups sliced firm ripe papaya
1 cup fresh shredded pineapple
½ cup orange juice
½ cup lemon juice
grated rind of 1 orange and 2 lemons
3 tablespoons grated green ginger root
1 cup sugar to each cup cooked fruit

Combine all ingredients except sugar and boil for 30 minutes. Measure cooked fruit, add an equal measure of sugar, and cook together for 30 minutes. Stir frequently to prevent burning, and when done pour into hot sterilized jars. Seal with paraffin, label, and store in cool place.

Papaya and ginger marmalade

yield 2 quarts

2 lemons, thinly sliced and cut in halves
1 teaspoon fresh ginger root, chopped fine
4 cups water
4 cups sugar
8 cups sliced firm ripe papaya

Cook lemon in 2 cups of water for 30 minutes, or until it becomes transparent. Make a syrup of the ginger, sugar and 2 cups of water by boiling. Add the syrup to the other ingredients and boil slowly for 30 minutes. Pour into hot sterile glasses and seal with paraffin.

Papaya pickle

yield 2 quarts

4 cups sugar
2 cups vinegar
12 cloves
16 peppercorns
4 bay leaves
8 cups half-ripe papaya pieces (1½ inches long and ½ inch wide)
2 cups water

Make a syrup of sugar and vinegar, cook 6 minutes. Add cloves, peppercorns and bay leaves. Cook papaya slices in the water for 5 minutes and add the drained fruit to the syrup. Cook mixture 15 minutes, pour into hot sterile jars and seal immediately.

Papaya sauce

6 servings

6 cups diced half-ripe or ripe firm papaya
1 cup sugar
½ cup water
4 tablespoons lemon juice

Stew all ingredients together for 20 minutes. Serve as fruit sauce with meat course or as dessert course. It is especially good for papaya shortcake filling. The sauce may be pressed through a coarse strainer if a smoother mixture is desired.

Stewed green papaya

6 servings

6 cups diced green papaya
¾ teaspoon salt
½ cup water
1 tablespoon butter
dash of pepper

Boil papaya in salted water until tender. Remove from fire, add pepper and butter, and serve hot as a vegetable. It may be mashed if preferred.

Baked papaya

6 servings

1 small firm ripe or half-ripe papaya
1 tablespoon butter
¾ teaspoon salt
2 tablespoons lemon juice

Pare and cut papaya lengthwise into six pieces, remove seeds. Sprinkle with salt, lemon juice and butter. Place in a baking pan, add enough water to cover bottom of pan to prevent burning, and bake in a moderate oven (350° F) for 35 minutes. Serve immediately after removing from the oven. This may be used in place of a vegetable.

Papaya salad

6 servings

4 cups diced papaya
6 teaspoons finely chopped onion
1 teaspoon salt
¾ cup cooked salad dressing or mayonnaise
1 cup finely chopped celery

Cut papaya into cubes, add the chopped onion and celery. Chill, serve on lettuce leaves and garnish with mayonnaise.

Royal Hawaiian delight

6 servings

¼ cup confectioner's sugar
8 marshmallows
½ cup shredded coconut
2 teaspoons lemon juice
1½ cups ripe papaya cubes
½ cup diced orange
1 cup whipping cream

Chill and whip cream, add sugar, then marshmallows cut in quarters. Fold in papaya, orange and coconut. Pour into serving dish or individual glass dishes, chill, and serve cold.

Pineapple and papaya cocktail

6 servings

2 cups diced ripe papaya
2 cups diced pineapple
6 tablespoons lemon juice
2 tablespoons sugar

Mix the ingredients. Allow to stand in a cold place for ½ hour before serving.

Papaya sauce cake

6 servings

¼ cup fat
1 cup sugar
1 egg
1½ teaspoons baking powder
½ teaspoon salt
⅓ teaspoon ground cinnamon
⅓ teaspoon grated nutmeg
¼ teaspoon ground ginger
1¼ cups flour
2 teaspoons lemon juice
½ cup seedless raisins if desired
1 cup diced ripe papaya
3 tablespoons water

Stew the papaya and water together until a soft smooth sauce is obtained. Press through a coarse sieve if necessary. Cream fat, add sugar, mix well, and add beaten egg. Sift salt, baking powder, spices and flour together. Add cooled papaya sauce and dry ingredients alternately to egg mixture. Fold in lemon juice and raisins; then pour into an oiled loaf-cake pan and bake in a moderate oven (350° F.) for 50 to 60 minutes.

Papaya upside down cake

6 servings

⅓ cup brown sugar
1 tablespoon butter
2 cups sliced papaya
2 tablespoons lemon juice
¼ cup fat
¾ cup sugar
1 egg
1¼ cups flour
1½ teaspoons baking powder
¼ teaspoon salt
½ cup milk

Pour lemon juice over papaya and allow to stand 15 minutes. Melt the butter and brown sugar in a hot skillet or shallow pyrex dish, then place a layer of the papaya slices on top of the sugar mixture. To prepare the cake mixture, cream the fat, add ¾ cup sugar and, when well mixed, add the beaten egg. Sift the salt, baking powder and flour together, and add to egg mixture, alternating with the milk. Pour this batter into the skillet and bake in a moderate oven (350° F.) from 50 to 60 minutes. When the cake is done turn it upside down on a large plate and serve hot with whipped cream.

Oahu papaya pie

4–6 servings

2 cups strained, stewed papaya sauce
1 tablespoon butter
2 egg yolks
¼ cup sugar
1 teaspoon ground ginger
1 teaspoon ground cinnamon
¼ teaspoon ground nutmeg
1 teaspoon salt
2 tablespoons lemon juice

Melt butter, add cooked papaya pulp, egg yolks, sugar, spices and lemon juice. Pour into a baked pie shell. Bake for 45 minutes or until firm in moderate oven (325° F.).

Papaya milk sherbet

yield 1 quart

1½ cups ripe papaya pulp
3 tablespoons lemon juice
1½ cups milk
1 cup sugar
½ cup orange juice

Press papaya pulp through a coarse sieve and combine with the fruit juice. Dissolve sugar in milk, add fruit mixture gradually to the milk, and freeze in ice-cream freezer using 8 parts of ice to 1 part of ice-cream salt. Ice cream may be made by substituting thin cream for the milk

Papaya mousse

6 servings

16 marshmallows
½ cup water
1 cup whipping cream
¾ tablespoon lemon juice
2½ tablespoons sugar
⅛ teaspoon salt
1 cup ripe papaya pulp

Soften marshmallows by heating slowly in water until a smooth mixture is obtained. Add sugar and cool to lukewarm; then add lemon juice and papaya pulp which has been pressed through a coarse sieve. Allow to stand in cool place until partially congealed. Chill and whip cream. Fold into the other mixture and freeze in mechanical refrigerator pan or in tightly sealed mold packed in a mixture of 3 parts of ice to 1 part of ice-cream salt. Seal mold with a strip of cloth dipped in hot paraffin or fat.

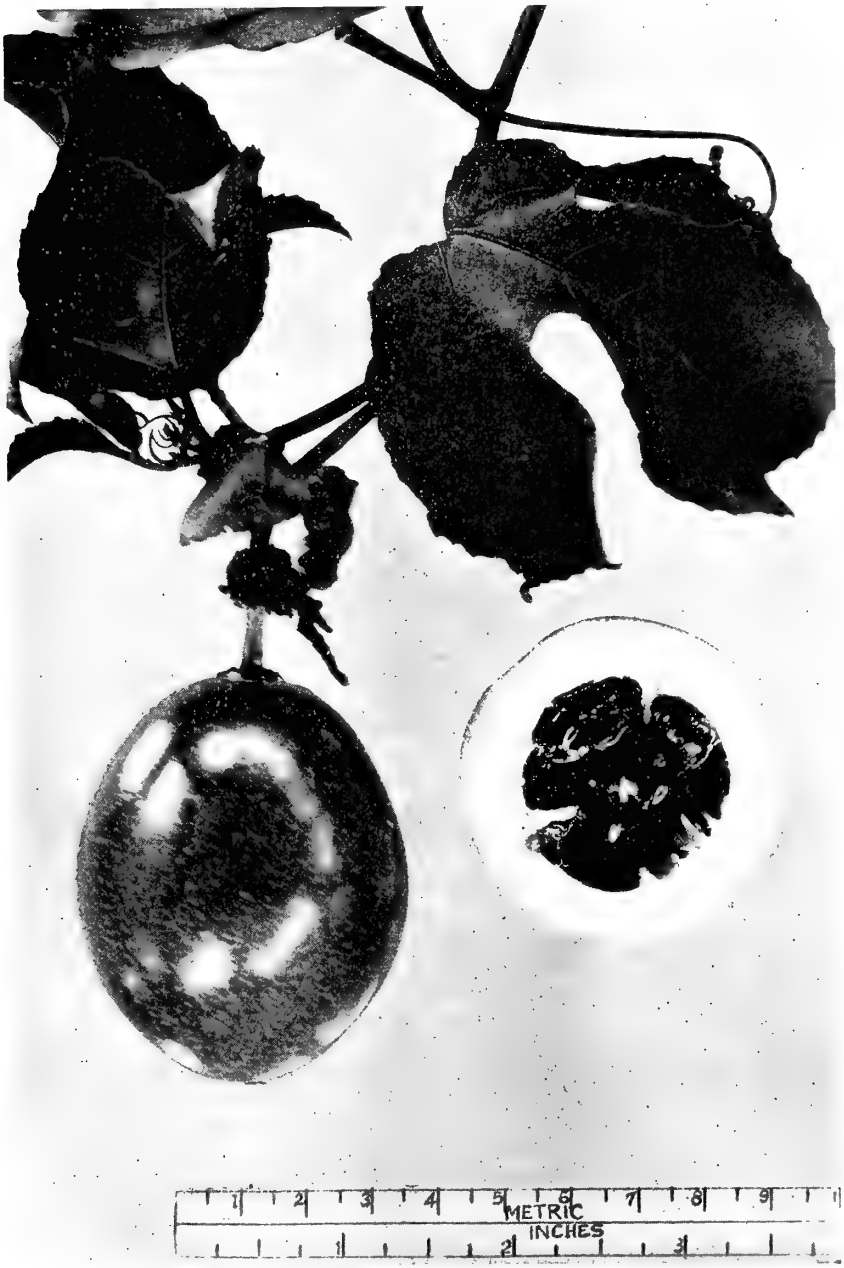

FIGURE 9.—Fruit, foliage and cross section of the yellow passion-fruit. *(Passiflora edulis* var. *flavicarpa)* 7/8 natural size

PASSION-FRUIT

(Passiflora edulis)

Description: The passion-fruit is a medium-sized oval fruit from 2 to 3 inches in length. There are two varieties common in Hawaii, the purple passion-fruit *(Passiflora edulis)* and the yellow passion-fruit *(Passiflora edulis* var. *flavicarpa)*. The brittle shell encloses a juicy, yellow pulp and many small seeds. Although the shell dries up and becomes wrinkled after the fruit has matured, the pulp remains in good condition for several weeks.

History: The passion-fruit is a native of Brazil but has been carried to all parts of the world. In many places it is grown only as a hot-house plant. Its unusual flowers inspired the Spaniards to name it the passion plant *(47, p. 149)*. In Australia, where the purple passion-fruit is very popular, it is cultivated on a large scale *(50, p. 242)*. In Hawaii, the purple variety is commonly called "lilikoi" because the first seeds of this variety, which were brought from Australia by Mr. Eugene Delemar, were planted in the district of Lilikoi on East Maui *(73)*. Although both purple and yellow varieties of the *Passiflora edulis* are locally called water-lemons, that term is correctly used only for the *Passiflora laurifolia,* which is grown to a limited extent in Hawaii.

Nutritive value: Analyses of the juice of the purple passion-fruit showed it to have a high sugar content and low calcium and phosphorus content. It is a fair source of iron.

The flowers and seeds of some varieties of passion-fruit are reported to contain a small quantity of an alkaloid *(30)*; but tests carried out by Raymond Nikaido under Dr. L. N. Bilger, of the Chemistry Department, showed the juice of the yellow passion-fruit to contain only faint trace of alkaloids.

They also attempted to account for the unusual keeping qualities of the passion-fruit juice by observing the growth of bacteria before and after partial or complete neutralization of the acid with sodium hydroxide, and by testing for the presence of such substances as salicylic and benzoic acid, which were proved absent. It was concluded that the keeping qualities of the juice are due to its natural high acidity. Table 2 shows the acidity of the purple passion-fruit juice to be 2.3 percent calculated as citric acid; the acidity of the yellow passion-fruit was found to be 3.9 percent.

No tests to determine the vitamin value of passion-fruit juice or pulp are reported in the literature, and no tests have been made in the station laboratory, except for vitamin C. The juice of the yellow passion-fruit was found to be an excellent source of vitamin C.

Supply: The passion-fruit ripens during the summer and fall, some as late as January. It is occasionally found in Honolulu markets.

Use: The fruit is prepared for use by cutting it in two and removing the pulp with a spoon. It may be eaten fresh out of the shell, or used to flavor candy, cake icing or frozen desserts. The distinctive

flavor of the fruit juice makes it a pleasant addition to iced drinks. A very satisfactory canned product may be prepared by adding the fresh passion-fruit pulp and a small quantity of tartaric acid to a boiling hot syrup. If bottled and sealed at once, it will keep indefinitely and may be used in place of the fresh fruit.

Passion-fruit coconut candy

yield 60 pieces

½ cup passion-fruit pulp
1 cup dry shredded coconut.
2¾ to 3 cups confectioner's sugar
English walnuts if desired

Press passion-fruit pulp through a coarse sieve in order to remove the seeds. Combine fruit pulp and two-thirds of the sugar. Beat until mixture is creamy, add one-half of the coconut and sufficient sugar to form a soft ball. Roll balls in coconut and place on a buttered pan. Garnish with nut meats if desired. Allow candy to stand at least 8 hours in a cold place to harden.

Passion-fruit syrup

yield 2 quarts

2⅔ cups passion-fruit pulp or 2 cups passion-fruit juice (24 fruit)
6 cups sugar
4 cups water
1 teaspoon powdered tartaric acid

Add sugar to water and heat to boiling. Press passion-fruit pulp through poi cloth or sieve to remove seeds. Add tartaric acid to pulp and mix with syrup. Pour into hot sterile bottles at once and seal. This syrup keeps well and may be used for iced drinks, cake icings and sherbets.

Passion-fruitade

6 servings

2 cups passion-fruit syrup
4 cup cold water

Mix, chill, and pour over cracked ice.

Fresh passion-fruit punch

6 servings

1⅓ cups fresh passion-fruit juice
1⅓ cups pineapple juice
2 cups sugar
1⅓ cups water
1⅔ tablespoons lemon juice

Press passion-fruit pulp through coarse sieve to obtain juice or squeeze through poi cloth. Mix ingredients, chill, and pour over cracked ice.

Passion-fruit punch

6 servings

1⅓ cups passion-fruit syrup
⅔ cup orange juice
2⅔ tablespoons sugar
3½ cups water
½ cup lemon juice

Mix ingredients, chill, and pour over cracked ice.

Passion-fruit cake icing*

yield 1⅓ cups

3 tablespoons butter
2¼ cups confectioner's sugar
¼ cup fresh passion-fruit pulp
or
3 tablespoons passion-fruit syrup

Press passion-fruit pulp through a poi cloth or sieve to remove seeds. Cream butter, add part of the sugar gradually; then add fruit pulp and remaining sugar, beating until the mixture is smooth and stiff enough to spread on cake.

Passion-fruit sherbet

6 servings

¾ cup sugar with passion-fruit syrup
or
2 cups sugar with fresh passion-fruit juice
¼ cup fresh passion-fruit juice or passion-fruit syrup
1 egg white
2 cups water

Combine sugar and water, then heat to the boiling point. Cool, add passion-fruit and unbeaten egg white, and pour into freezer. Freeze, using 8 parts of ice to 1 part of ice-cream salt.

Passion-fruit ice cream

6 servings

¾ cup sugar with passion-fruit syrup
or
1 cup sugar with fresh passion-fruit juice
2 cups thin cream
½ cup passion-fruit syrup or fresh passion-fruit juice
½ tablespoon vanilla

Add other ingredients to cream and stir until dissolved. Pour into freezer and freeze, using 8 parts of ice and 1 part of ice-cream salt.

Passion-fruit mousse

6 servings

½ tablespoon gelatin
2 tablespoons cold water
3 tablespoons boiling water
1¼ cups passion-fruit syrup
1 cup whipping cream

Soak gelatin in cold water, then add boiling water, and melt over hot water until thoroughly dissolved. Chill and whip cream, fold in syrup and gelatin. Freeze from 4 to 5 hours in mechanical refrigerator pan or in tightly sealed mold packed in ice, using 3 parts of ice to 1 part of ice-cream salt. Seal mold by using narrow strip of cheesecloth dipped in melted paraffin or lard.

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* Adapted from receipe booklet from Kremer Plantations, Cardiff-By-The-Sea, California.

PINEAPPLE

(Ananas sativus)

Description: The pineapple is really a collection of small fruits and is called a multiple fruit. In the flower stage, the corollas are separate but the ovaries are fused, giving the appearance of a dense cluster of perfect flowers on a single stalk. The mature pineapple is a large fruit shaped like a pine cone or pyramid about 6 to 10 inches in height and weighing 5 to 8 pounds. It grows on a stalk or peduncle which is a continuation of the plant stem of the low cactus-like pineapple plant. The rind, which is usually sliced off with a sharp knife, is tough and horny and composed of small hexagonal sections, fitted together like pieces of tile. Each of these sections marks a botanically individual fruit. The color of the skin when ripe is usually bright greenish-orange shading to yellow-green or dark green. The flesh is very juicy and has a somewhat fibrous texture. In color it varies from white to deep yellow. The edible portion surrounds a tough central core which was originally the flower stalk.

History: The pineapple is a native of Central or South America and early became a favorite luxury of wealthy Europeans. The history of the introduction of the pineapple into Hawaii is not known, but it is generally believed that it was brought in by some Spaniard who had previously touched the coast of South America. Although Don Marin records in his diary in 1813 that pineapples were growing in his garden at that time *(74, p. 46)* they were probably first planted on the island of Hawaii, where they now grow wild. A pineapple similar to the Wild Kailua pineapple also grows in Guam, Formosa and the Philippine Islands *(7)*. In the fresh state some of this half-wild fruit was shipped to San Francisco before 1880, but was not received in satisfactory condition because the fruit spoiled easily and was of poor quality.

The pineapple industry was of minor importance in Hawaii until 1886, the date of the introduction of the Smooth Cayenne variety. The first pineapple was canned commercially in 1892, and from that time on the industry developed until today it is the second largest industry in the islands.

Nutritive value: The pineapple has long been valued for its distinctive flavor and refreshing qualities.

Fresh ripe pineapple is a good source of sugar and calcium. Pineapple juice has a higher calcium content than guava juice or orange juice from Hawaiian oranges. The phosphorus and iron content of the fresh pineapple and the fresh pineapple juice are low as compared with many other fruits in this series.

Determinations of the vitamin value of fresh and canned pineapple were made in 1923 *(31) (32)* by the methods then in use, and the conclusion was drawn that pineapple is a good source of vitamins A, B and C. Tests made by the more quantitative methods used for the fruits reported in this bulletin show fresh pineapple of the Smooth Cayenne variety to be a less good source of vitamins A and C than was formerly

supposed. Pineapple has much less vitamin A than papayas or pohas, half the quantity possessed by guavas and about the same quantity as have fresh figs of the Brown Turkey variety. As a source of vitamin C, pineapple is surpassed by guavas, papaya, pohas and oranges.

Pineapple juice, even when consumed in large quantities, tends to make the urine more alkaline *(33)*. Nelson *(40)* has shown that of the non-volatile acids in pineapple juice, about 87 percent is citric and about 13 percent is l-malic.

Some people find that eating large quantities of fresh pineapple causes a soreness of mouth and oesophagus. It has been suggested that this irritation may result from the combined action of the acid, the protein splitting enzyme bromelin and the calcium oxalate crystals *(33)*.

Supply: Though the greater portion of the crop is used for canning, excellent pineapples are to be found in the Honolulu markets during the entire year. The fruit is most plentiful during June, July and August, but a second and smaller crop comes on during December and January.

Use: Pineapples are frequently used fresh, served alone, or combined with such other fruits as the avocado, banana, citrus fruits, mango and papaya. Pineapple combines well with such vegetables as carrots and cabbage in salads. Finger-length slices of pineapple are delicious served in iced tea. The juice makes an excellent iced drink or may be combined with other fruit juice for punch. Pineapple may be preserved in the form of jams or pickles, but home canning is not practical in most localities. There is not enough pectin present to make jelly from the juice. Pineapple must be cooked before being added to a gelatin solution because the enzyme, bromelin, present in uncooked pineapple will prevent the gelatin from congealing.

Fresh pineapple juice
yield 2½–3½ cups

Cut a peeled ripe pineapple in 8 or more pieces and squeeze through one thickness of poi cloth or sugar sack. Chill juice and serve. Even with pineapples selling at 3 cents a pound, juice prepared at home is as inexpensive as the juice purchased on the market.

Pineapple punch
6 servings

4 cups fresh pineapple juice	⅔ cup sugar
⅔ cup orange juice	⅔ cup water
⅓ cup lemon juice	1 teaspoon finely chopped mint leaves

Boil sugar and water 3 minutes, cool, and combine with fruit juice and mint. Chill and pour over cracked ice.

Pineapple pickle

yield 5 cups

- 3 cups white vinegar
- 3½ cups sugar
- 3 cups water
- 2 tablespoons whole cloves
- 2 sticks cinnamon
- 12 cups pineapple sections (2 medium sized fruit)

Peel pineapple, cut crosswise in slices 1 inch thick. Remove core and cut into sections about 1 inch wide. Combine with vinegar, sugar and water; tie spices in cheesecloth, add to mixture, and boil slowly 15 minutes. Add pineapple and boil gently in covered container for 1½ hours or until tender. Pour into hot sterile jars and seal immediately.

Pineapple honey preserve

yield 2 quarts

- 10 cups pineapple sections
- 2 cups orange peel, sliced fine (6 medium-sized oranges)
- 2 cups orange sections
- ⅓ to ½ cup finely chopped fresh ginger root
- 3 cups strained honey

Peel a fresh pineapple and cut crosswise in slices about ¾ inch thick. Remove core and cut in sections ¾ inch wide. Remove rind from 6 oranges, cutting so that the membrane is removed from orange pulp. Soak rind in water for ½ hour. Drain and cook until tender, changing the water 3 times during the cooking process. Drain, wash with cold water, and remove white pulp from inside of rind by scraping with a spoon. Cut rind in narrow strips. Remove membrane from orange sections.

Combine pineapple, orange rind, ginger and honey. Cook over a slow fire until pineapple is partially tender. Add orange sections and continue cooking until pineapple is tender. Drain off honey and evaporate to a thicker consistency over a very low fire. Pack pineapple mixture in hot sterile jars, fill with hot syrup, and seal immediately.

Pineapple jam

yield 2¼ quarts

- 12 cups grated or chopped fresh pineapple (2 large fruit)
- 6 cups sugar
- 6 tablespoons lemon juice
- rind of 3 lemons, sliced in very narrow strips ½ inch long

Combine pineapple and sugar and allow to stand over-night. Add lemon juice and rind, then cook slowly for 2 hours. Pour into hot sterile jars and seal with paraffin.

Pineapple conserve

yield 6¾ cups

- 6 cups diced pineapple
- 2 cups orange sections
- 1 cup broken English walnut meats
- ½ cup finely sliced orange peel
- 1 cup seedless raisins
- 6 tablespoons lemon juice
- ¾ cup water
- ¾ cup sugar to each cup of the cooked mixture

Remove rind from the oranges and scrape out the inner white pulp with

a spoon or dull knife. Cut rind into very narrow strips. Remove the membrane from the orange sections.

Combine the diced pineapple and water; cook until it begins to soften, then add all the remaining ingredients except the sugar. Measure this fruit mixture and for each cupful add ¾ cup of sugar. Cook over a slow fire until it thickens. Pour into hot sterile jars and seal at once.

Pineapple chutney*
yield 2 quarts

2 ounces small red peppers with seeds removed, chopped fine
1 ounce or 1 medium-sized bulb of garlic, chopped fine
2 tablespoons of finely chopped fresh ginger root
1 tablespoon salt
3 pound peeled pineapple
1½ pounds brown sugar
1½ pints vinegar
½ pound seedless raisins
½ pound blanched almonds, chopped fine

Cut the pineapple in small pieces, add vinegar and salt, cook slowly until pineapple is tender. Add the other ingredients and boil slowly until desired consistency is obtained. Pour into hot sterile jars and seal immediately. Serve with meats or curried dishes.

Pineapple carrot salad
6 servings

3 cups shredded fresh pineapple
¾ cup mayonnaise
2 cups shredded or grated raw carrot

Mix pineapple and carrot, chill, drain off juice, place on lettuce leaves, and serve with mayonnaise.

Pineapple cabbage salad
6 servings

4 cups shredded cabbage
2 cups shredded fresh pineapple
½ cup mayonnaise
⅛ teaspoon salt

Combine cabbage and pineapple and chill. Drain off juice, add salt, serve on lettuce leaves, and garnish with mayonnaise. Chopped peanuts or chopped green pepper may be added for color if desired.

Pineapple crab salad
6 servings

2½ cups diced fresh pineapple
1½ cups shredded crab meat
⅔ cup mayonnaise
1½ tablespoons tomato catsup
1 teaspoon Worcestershire sauce

Mix chilled pineapple and crab meat and serve on lettuce leaves. Add catsup and Worcestershire sauce to mayonnaise and pour over salad.

* From How to Use Hawaiian Fruit and Food Products—Agnes B. Alexander, Honolulu.

FIGURE 10.—Poha *(Physalis peruviana)*
Plant ½ natural size. Fruit x1, flowers x2, seeds x5.
—After Degener, *Flora Hawaiiensis.*

POHA

(Physalis peruviana)

Description: The poha is a small yellow-green or orange fruit resembling a cherry in size and shape, enclosed in a thin, cream-colored, paper-like husk. The skin of the fruit is thin and waxy and surrounds a juicy pulp which contains many small seeds. It is also called the Cape gooseberry or husk tomato, and is related to the ground cherry.

History: This plant was introduced into the Hawaiian Islands very early after the beginning of travel to the Islands by Europeans. Very likely it was brought here in the early 19th century from the Cape of Good Hope, where it has been known for some time *(47, p. 212)*. It is a native of Brazil but is now grown in many tropical and sub-tropical countries *(20, p. 310)*. In Hawaii it grows well, especially on the islands of Maui and Hawaii at heights from 1500 to 4000 feet.

Nutritive value: In comparison with other Hawaiian fruits, pohas have a low calcium content, and a high phosphorus and iron content.

Pohas are an excellent source of vitamins A and C, a good source of vitamin B and a fair source of vitamin G. Because of the high acidity of pohas, the vitamins are probably well preserved after cooking.

Supply: The pohas in Honolulu markets come from both the cultivated and wild plants, but there seems to be little difference in appearance or flavor between the wild and the cultivated. They are to be found on the market from February through July, the supply seldom exceeding the demand.

Use: The poha has a pleasing and distinctive flavor and may be used raw in much the same ways as the strawberry for a dessert or shortcake. It may be cooked and served as a sauce on cakes and puddings, but the favorite way of using the poha is in jam. The pectin content is low, although the acid is high.

Poha fruit cup

6 servings

- 1½ cups diced pohas
- 1½ cups diced bananas
- ½ cup diced orange
- 1 cup diced fresh pineapple
- ¼ cup lemon juice
- ½ to ¾ cup sugar
- 2 teaspoons finely chopped mint

Mix all ingredients, chill, and serve in cocktail glasses. This also makes a good salad combination if the lemon juice, sugar and mint are omitted and the fruit served on lettuce leaves with mayonnaise.

Poha pineapple cocktail

6 servings

- 2 cups diced pohas
- 2⅔ cups diced fresh pineapple
- ¼ cup lemon juice
- ¼ cup sugar

Mix ingredients, chill thoroughly, and serve in cocktail glasses.

Poha sauce for puddings

6 servings

- 3 cups diced pohas
- 1⅞ cups sugar
- 2 tablespoons cornstarch
- ¼ teaspoon salt
- 1½ cups water or pineapple juice
- ½ tablespoon vanilla
- 1 tablespoon butter

Add ½ cup of the sugar to the pohas and allow to stand 15 minutes. Add water or pineapple juice and bring to boiling point. Mix remaining sugar, salt and cornstarch together thoroughly and add to hot liquid, stirring constantly. Boil 5 minutes, remove from fire, and add butter and vanilla. Serve hot or cold on cake, or on rice or bread puddings.

Poha jam

yield 1½ quarts

- 6 pounds pohas before husking or 4 quarts after husking
- 1 cup sugar for each cup of cooked pohas (5-6 cups)

Husk, wash, and cook pohas slowly for 30 minutes. Stir frequently until there is sufficient liquid to prevent fruit from scorching. Allow to stand over-night. Measure poha pulp and juice and add an equal quantity of sugar. Cook slowly for about 1¼ hours, stirring frequently until juice thickens slightly when cooled. Pour into hot sterile jars and seal with paraffin.

The quantity of juice resulting from the cooking process varies with the pohas obtained during the dry and rainy seasons. When the water content of pohas is unusually high, it is necessary to pour off some of the juice before adding the sugar, if a greater portion of the fruit than jelly is desired.

Poha preserves

yield 2¼ quarts

- 6 pounds pohas before husking or 4 quarts after husking
- 2 lemons, sliced very thin and sections cut in halves
- ⅓ cup sugar
- 1⅛ cups sugar to 1 cup cooked poha pulp and juice

Husk and wash pohas and cook over a low flame. Stir frequently until there is sufficient liquid to keep the fruit from scorching. Cook for 30 minutes, or until fruit is soft. Drain the juice from the fruit and pour 1 cup of juice over the lemon slices. Add ⅓ cup of sugar and allow to stand overnight, then cook the lemon in this liquid until the rind is transparent. Add lemon and liquid to pohas; measure and add 1⅛ cups of sugar to each cup of poha mixture. Cook until this mixture thickens slightly but not until the juice gives the jelly test. Pour into hot sterilized jars and seal with paraffin.

FIGURE 11.—Fruit and foliage of the soursop.
(Annona muricata) ½ natural size

SOURSOP

(Annona muricata)

Description: The soursop is a large, heart-shaped fruit. A single fruit may weigh 5 pounds, and much larger ones have been reported *(50, p. 183)*. The thick skin, or rind, is a deep green and covered with numerous short, pliable spines. The flesh resembles cotton soaked in a highly aromatic liquid. The pulp contains many shiny brown seeds.

History: The fruit is a native of tropical America *(50, p. 183)* and was described as early as 1528 by Gonzalo Hernandez de Oviedo in his "Natural History of the Indies." At present, it can be found in most tropical countries, although it is probably more popular in Cuba than in any other place. The name "soursop" by which the fruit is known in most English speaking countries is of West Indian origin. The history of its introduction into Hawaii is unknown.

Nutritive value: Soursops are a fair source of calcium and iron but have better than average quantities of phosphorus.

Because there appears to be no yellow pigment in soursops, it was thought not worth while to test them for vitamin A. The thick juice resulting when the soursop was pressed in two thicknesses of cheesecloth was used for the vitamin tests and was found to be a good source of vitamins B and C. No tests for vitamin G were made.

Supply: In Honolulu, the soursop is occasionally found in the markets but the supply is not equal to the demand. The season ranges from February to September.

Use: The soursop has an acid flavor and a pleasant refreshing odor. The juice may be extracted by forcing the pulp through a potato ricer or fruit press or by squeezing it through several thickness of cheesecloth. The pulp freed from the seeds and pulled or cut into small pieces may be chilled and served as a breakfast fruit with the addition of sugar, or it may be used in a salad. Iced drinks, sherbets and gelatin dishes may be made from the extracted juice. It blends well with banana, orange and pineapple.

Soursopade

6 servings

3⅓ cups soursop juice	1 cup sugar
2⅔ cups water	2⅔ tablespoons lemon juice

Mix ingredients, stir until sugar is dissolved, pour over cracked ice and serve.

Soursop and pineapple sherbet

6–8 servings

1½ cups soursop juice
1 cup pineapple juice
1 cup sugar
1 egg white
1 cup water

Combine sugar and water and boil 5 minutes. Cool to lukewarm, add fruit juice and unbeaten egg white, and freeze in an ice-cream freezer using 8 parts of ice to 1 part of ice-cream salt.

Soursop sherbet

yield 1½ quarts

2 cups soursop juice
2 cups water
⅞ cup sugar
1 egg white
1 tablespoon lemon juice

Make a syrup of sugar and water by boiling 5 minutes. Cool to lukewarm. Add soursop juice and unbeaten egg white, and pour into freezing container. Freeze with 8 parts of ice and 1 part of ice-cream salt.

Soursop mousse

6 servings

20 marshmallows
¼ cup water
1 cup soursop juice
1 cup whipping cream
2 tablespoons sugar

Add sugar and marshmallows to water, heating slowly until marshmallows are softened and a smooth mixture is obtained. Cool, and add soursop juice. Allow to stand in a cool place until partially congealed, then add cream which has been whipped. Pour into mold and freeze in a mechanical refrigerator or in a mixture of 3 parts of ice to 1 part of ice-cream salt.

STRAWBERRY

(Fragaria chiliensis)

Description: The cultivated strawberry is a juicy, red fruit which grows on a low, herbaceous plant. Structurally, it is an enlarged fleshy receptacle from ½ to 1¼ inches in diameter, on the outside of which are imbedded many small seeds. *(4, p. 594)* The flavor is characteristic and combines acidity and sweetness in proportions pleasing to most people. Some varieties are more strongly flavored than others.

History: There are numerous varieties of the strawberry native to widely separated sections of the world. These vary considerably in size, shape, color and flavor. Many varieties have been developed under cultivation. There is a white strawberry indigenous to Hawaii which at one time was fairly abundant on the islands of Kauai and Hawaii. At the present time, as the cattle have destroyed most of the plants, it is found only in the more inaccessible places. During the last 10 or 15 years, because of the successful importation of commercial varieties, the cultivation of strawberries has increased greatly in Hawaii.

Nutritive value: In comparison with other fruits, strawberries may be considered a good source of calcium, phosphorus and iron. The values we found for iron are high and may be in error because of contamination with soil, although great care was used in preparing the sample.

Strawberries are reported to be a fair source of vitamins A and B and a very good source of vitamin C *(39)*.

Supply: The supply is small, fairly constant and usually equal to the demand. The season ranges from December through July.

Use: In Hawaii, strawberries are practically always used fresh because they are too expensive to buy for preserving, the price ranging from 15 to 25 cents a pint.

FIGURE 12.—Fruit and foliage of the Surinam-cherry. *(Eugenia uniflora)* ⅜ natural size

SURINAM-CHERRY (Pitanga)

(Eugenia uniflora)

Description: The Surinam-cherry is a small, bright-red fruit about 1 inch in diameter, "oblate in form and conspicuously eight-ribbed." *(50, p. 287)*. The flesh surrounding the single large seed is soft, juicy and distinctly acid in flavor.

History: The Surinam-cherry or Pitanga, as it is known in Brazil, where it grows wild along the banks of the streams and edges of the forests, *(50, p. 286)*, is also an important cultivated fruit of that region. Popenoe reports that it is used more extensively by the inhabitants of Brazil than any other country. The date of its introduction into Hawaii is unknown.

Nutritive value: The acidity of Surinam-cherries is great compared with other fruits in this series and is exceeded only by tamarinds and the yellow passion-fruit. The expressed juice from 2 different samples showed pH values of 2.7 and 3.0. Due to this high acidity, the fruit does not seem very sweet to taste although it has a large quantity of carbohydrate—22 percent—which must be mainly sugars.

Surinam-cherries are a good source of calcium, and a fair source of phosphorus and iron, having about the same quantities of these minerals as seeded guavas.

No tests to determine the vitamin values of Surinam-cherries are reported in the literature and no tests have been made in the station laboratory.

Supply: Surinam-cherries are not sold in Honolulu markets. The quality and quantity of the fruit obtainable from private gardens varies with the amount of moisture. The season ranges from March through the early part of May.

Use: In Hawaii, the Surinam-cherry is frequently grown for decorative purposes. The cherries may be cooked and used as a sauce, or for jam, preserve or jelly. Because of the tart flavor, the sauce, resembling cranberry sauce, the jelly or tart sherbet made from the cherry juice are best when served with meat or fowl. Combined with apple and raisins, the cherries may be used for pies or puddings. The juice, prepared as for jelly making, may be used as a foundation for an iced drink. The juice of the firm ripe cherries gave a good test for pectin. The fruit and juice are high in acid and seem to develop a bitter taste on standing so that they should be used as soon after picking as possible.

Surinam-cherry jam

yield 1 quart

3¾ cups seeded Surinam-cherries	2 cups water
	3¾ cups sugar

Combine the sugar and water, bring to the boiling point, and add cherries. Cook slowly for 20 to 25 minutes until the juice thickens slightly, but not until it gives the jelly test (sheets off the spoon in large drops).

Pour into hot sterile jars and seal with paraffin.

Surinam-cherry jelly

yield 5 cups

5 pounds Surinam-cherries
7½ cups water or enough to barely cover the fruit
1 cup sugar to each cup of juice

Wash cherries, remove stems and blossom ends. Add water to the fruit and simmer for 25 minutes, or until the cherries are soft. Strain the juice through a flannel jelly bag or two thicknesses of a sugar or flour sack.

Measure the juice and place it in a shallow kettle with a capacity at least 4 times the volume of juice. Heat to the boiling point and boil 5 minutes. Add an equal quantity of sugar and remove the scum as the mixture starts to boil. Boil rapidly until the juice gives the jelly test (sheets off the spoon in large drops), or until the temperature reaches 105° Centigrade, or 221° Fahrenheit on a clear, dry day; or 106° Centigrade or 222° Fahrenheit on a damp, cloudy day. Pour the jelly into hot sterile glasses and seal with paraffin.

Surinam-cherry punch

6 servings (1 cup)

1⅛ cups Surinam-cherry juice
4½ cups water
3 tablespoons lemon juice
1⅓ cups sugar

Prepare Surinam-cherry juice as directed in the recipe for jelly. Combine all the ingredients, stir until the sugar is dissolved, and pour over cracked ice before serving.

Surinam-cherry sauce

yield 1 pint

1 pound or 1 pint Surinam-cherries
½ cup water
1¼ to 1½ cups sugar

Wash cherries and remove blossom ends. Add water and simmer 20 minutes over a low fire. Remove from fire, press the cherries through a coarse sieve to remove the seeds, add sugar to the fruit pulp and reheat to dissolve sugar. Cool and serve with meat or fowl. This makes a thin sauce. A few minutes additional cooking is necessary to make a product stiff enough to mold.

Surinam-cherry pie

4 to 5 servings

1¼ cups seeded Surinam-cherries
½ cup seedless raisins
¾ cup diced apple
1⅛ cups sugar
3 tablespoons flour
1 teaspoon butter

Line a pie tin with pastry. Mix the fruit and pour into the pie shell. Sprinkle with flour and sugar and dot with small pieces of butter. Moisten the edge of the pie crust and cover with a second crust. Place in a hot oven (450° F.) for 10 minutes, then reduce the temperature to 350° F. and bake for 30 to 40 minutes or until the fruit is soft.

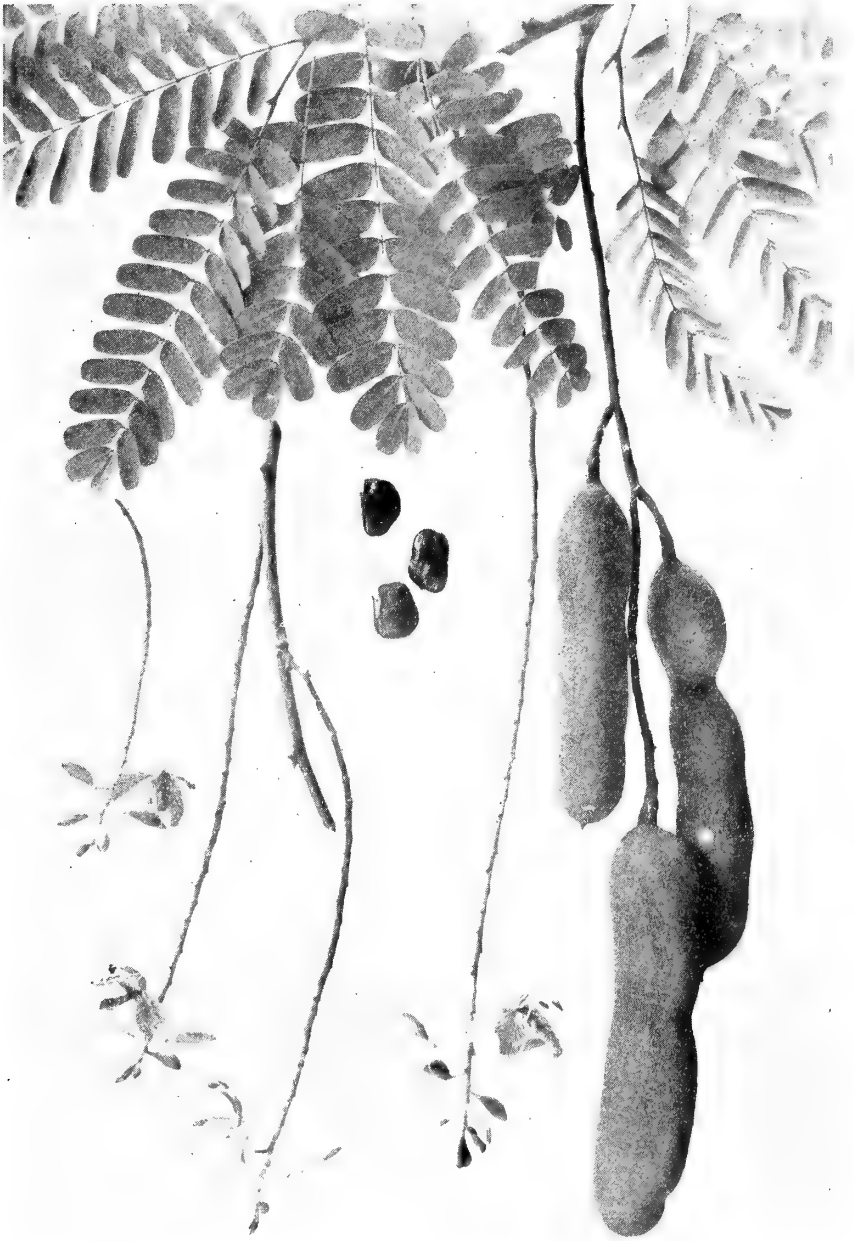

FIGURE 13.—Fruit, foliage and seed of the tamarind. *(Tamarindus indica)* ½ natural size

TAMARIND

(Tamarindus indica)

Description: The fruit of the tamarind tree consists of a brittle brown pod, varying from 2 to 6 inches in length and from ½ to 1 inch in width. This encloses a very sticky, acid pulp surrounding from 1 to 12 shiny brown seeds. This edible pulp shrinks slightly from the pod in maturity.

History: The tamarind is believed to be a native of tropical Africa and perhaps southern Asia, where it has long been popular *(50, p. 433)*. It was early introduced into tropical America and from there was probably brought to Hawaii. One of the first tamarind trees in Hawaii was planted in 1797 by Don Marin at Little Greenwich in Paoa Valley *(22)*. It was a favorite tree of the early settlers and is found on many of the old homesteads. An avenue of tamarind trees grew in the palace grounds until King Kalakaua, who did not like the fruit, had the trees removed. In more recent years, the fruit has lost its popularity, partly because of the small beetle which infests most of the pods and partly because of the availability of other fruits.

Nutritive value: Our analyses and those of others *(51) (63)* indicate that tamarinds, as compared with all other fruits, have an unusually high acid and high sugar content. The acid is reported to be largely tartaric and a small amount of undetermined acids. The acid of the sample analyzed in the nutrition laboratory was calculated as 14.24 percent tartaric acid or 12.16 percent as citric acid. The metabolism of tartaric acid has been discussed under "grapes" (page 31).

One investigator reports for tamarinds an invert sugar content of 41.2 percent *(51)*, and our analyses show a carbohydrate by difference of 45.8 percent.

The calcium and phosphorus content are also unusually high; the value of 0.113 percent for calcium is the highest reported in the literature for any fruit and is equivalent to that reported for some vegetables.

Though some people find the highly acid taste objectionable, many children like tamarinds well enough to strip the trees of the fruits wherever they have the opportunity. Perhaps those children who have a low calcium intake could increase it considerably by eating tamarinds during the fruiting season, but additional experimental work is necessary before we can decide if it is a practice to be especially recommended. At any rate, it is probably not a detrimental one.

Tamarinds are an excellent source of vitamin B but have little or no vitamins A or C. Preliminary tests indicate that they are probably a good source of vitamin G (page 126).

The 1932 Medical Research Council report on vitamins *(29)* lists dried tamarinds as having a low antiscorbutic value but states that the dried fruit is much esteemed as an antiscorbutic by natives of India. The results of our experiments (page 123) seem to justify a statement that tamarinds are a poor source of vitamin C.

Supply: In Hawaii, the fruit ripens during the late summer and fall. No attempt is made to market it commercially.

Use: Tamarinds are much more widely used in the other tropical countries than in Hawaii, although many children eat the edible portion within the pod as do the East Indians and Arabs who prize tamarinds as highly as dried dates and figs. Two methods of preserving tamarinds indefinitely are to press the shelled tamarinds into cakes and keep in a cool place, or to pack the whole tamarind in alternate layers with sugar in jars. Another way is to cook the shelled fruit in a syrup until quite soft and put through a coarse sieve, pressing through as much pulp as possible. This syrup may be canned to be diluted later and used in making a pleasing and refreshing iced drink. Because of their high acidity, tamarinds may be substituted for lemons or limes. Popenoe *(50, p. 434)* states that in the Orient tamarinds are widely used as an ingredient of chutneys and curries and for pickling fish.

Fresh tamarindade

6 servings

21 shelled tamarinds — ¾ cup sugar

6 cups water

Add tamarinds to water and allow to stand 10 minutes. Stir well, add sugar, chill, and serve with cracked ice.

Tamarind syrup

yield 2 quarts

2 cups shelled tamarinds pressed down in cup — 6 cups water

5⅓ cups sugar

Pour water over tamarinds and allow to stand over-night. Add sugar and boil 15 minutes. Strain through a coarse seive, rubbing through as much pulp as possible. Heat syrup to boiling, pour into hot sterile jars, and seal.

Tamarindade

6 servings

1 cup tamarind syrup — 4¾ cups water

6 sprigs of mint

Mix syrup and water, chill, and serve with cracked ice and a sprig of mint in each glass.

WATERMELON

(Citrullus vulgaris)

Description: The watermelon is a large, smooth green melon cultivated in many sections of the world. The rind varies from ⅜ to 1½ inches in thickness and, from the outside in, shades from green to white to pink. The crisp, juicy, pink flesh contains many black or white, flat, slippery seeds. In good melons, the flavor is delicate, sweet and refreshing. The watermelons grown in Hawaii average between 10 and 20 pounds and are usually round. Comparatively few large melons (more than 20 pounds) are seen on the market.

History: The watermelon is a native of Africa but has spread throughout the world. David Livingston *(3, p. 2031)* in 1857 wrote that during years of abundance in Africa, watermelons were plentiful and were a favorite food of the wild animals as well as the natives. Although in Hawaii a large supply of melons has been grown only during the last few years, some variety has been grown here continuously since the first seeds were left by Captain Cook in 1779 *(74, p. 45)*.

Nutritive value: Watermelons, like strawberries and mountain apples, contain 90 percent or more of water and 7 to 8 percent of carbohyrate in the the form of sugar.

Watermelons are low in calcium, phosphorus and iron.

Vitamin determinations made elsewhere *(38)* show watermelons to be a fair source of vitamin A, a poor source of vitamins B and G, and a fair to good source of vitamin C.

Supply: Watermelons are on the market from May to August, the supply usually meeting the demand.

Use: Delicious watermelon is grown in Hawaii, which provides a favorite and refreshing dessert. It may be used for fruit cocktail with the addition of lemon or grapejuice, or combined with other fruits. Fruit salad is made very attractive by the addition of watermelon cubes or balls. The rind may be prepared as a preserve or pickle.

Watermelon cocktail

6 servings

4 cups ripe watermelon cubes	1 tablespoon sugar
4½ tablespoons lemon juice	$\frac{1}{16}$ teaspoon salt

Add salt and sugar to lemon juice, pour over watermelon cubes, chill, and allow to stand 1 hour or more in a refrigerator before serving in cocktail glasses. A sprig of fresh mint may be used as a garnish for each serving.

Watermelon grape juice cocktail

6 servings

4 cups ripe watermelon cubes	4½ tablespoons lemon juice
5 tablespoons grape juice	$\frac{1}{16}$ teaspoon salt

Mix salt, lemon juice and grape juice, pour over watermelon cubes, chill, and allow to stand 1 hour or more in a refrigerator before serving in cocktail glasses.

Watermelon pickle

yield 1½ quarts

3 pounds or 2½ quarts watermelon rind (rind from one melon)
6–7 cups salt water (1 tablespoon salt to 1 cup water)
4–5 cups weak vinegar solution (1 cup vinegar to 2 cups water)
1½ cups strong vinegar
1½ cups sugar
2½ cups water
1 tablespoon whole allspice
1 tablespoon whole cloves
2 tablespoons stick cinnamon
¼ teaspoon salt

Pare watermelon rind, removing all outside green rind and practically all the pink meat. Cut in pieces about 3 inches long and ¾ inch wide. Soak 24 hours in sufficient salt water to cover rind. Drain and soak 24 hours in sufficient vinegar solution to cover rind. Drain and cook in clear water 1½ hours, or until tender; then drain off water. Make a syrup by heating vinegar, sugar, water and salt. Tie spices loosely in piece of cheesecloth and add to mixture. Cover and allow to stand 1 hour to absorb spice flavor.

Add rind and boil gently for 1½ hours in a covered kettle. Pour into hot sterile jars and seal at once. Exposure to air darkens the pickle.

SUMMARY

The nutritive value of 22 semi-tropical fruits grown in Hawaii has been studied. Chemical analyses include moisture, protein, ether extract, crude fiber, carbohydrates by difference, ash, titratable acid, calcium, phosphorus and iron. In some cases several varieties of the fruit (e.g. avocados, bananas, etc.) have been analyzed. In a number of instances analyses were made on the fruit in different forms (e.g. grapes without seeds and without seeds and skins, pineapple and pineapple juice, oranges with and without membranes and orange juice, etc.).

In the case of some fruits no previous analyses for the mineral constituents, calcium, phosphorus and iron, appear to have been made. Where comparisons were possible, the chemical composition of local fruits appears to be similar to the same varieties grown elsewhere.

Ten fruits were tested biologically for their vitamin content. In some instances several forms of the same fruit were tested separately such as pulp and juice. In the case of vitamins A and B comparisons were made with the International Standards. Guavas are noteworthy for their high vitamin C content and papayas and pohas for their high vitamin A (carotinoid pigment) content.

The supply and availability in Hawaii, brief descriptions and interesting notes regarding the history and introduction into Hawaii are given for each fruit.

More than 150 recipes are given for the use of these fruits grown in Hawaii.

TABLE 1.—*Classified list of Hawaiian fruits studied.*

Common Name	Scientific Name	Variety Analyzed	Source of Sample Analyzed
Avocado	*Persea americana*	Hulumanu	Haw. Avocado Co., Pupukea, Oahu
		Nabal	Cooper Ranch, Laie, Oahu
Banana	*Musa sapientum*	Bluefields (Gros Michel)	Windward Pali, Oahu
		Brazilian	Windward Pali, Oahu
		Largo	Haw. Agr. Expt. Sta., Honolulu, Oahu
Breadfruit	*Artocarpus communis*	Hawaiian	Mary E. Foster Est., Honolulu, Oahu
Carambola	*Averrhoa carambola*	No established varieties	Haw. Agr. Expt. Sta., Honolulu, Oahu
Coconut	*Cocos nucifera*	Unknown	Waialae Golf Club, Oahu
Coffee	*Coffea arabica*	No anaylses made	
Fig	*Ficus carica*	Brown Turkey	Punaluu, Oahu
Grape	*Vitis labrusca*	Isabella	Manoa, Oahu
Guava	*Psidium guajava*	Common	Waimanalo, Oahu Manoa, Oahu
	Psidium cattleianum	Strawberry	Haw. Agr. Expt. Sta., Tantalus, Oahu
Lemon	*Citrus limonia*	No analyses made	
Lime	*Citrus aurantifolia*	No analyses made	
Litchi	*Litchi chinensis*	Hei Yeh	Haw. Agr. Expt. Sta., Honolulu, Oahu
		Kwai Mi	Haw. Agr. Expt. Sta., Honolulu, Oahu
Mango	*Mangifera indica*	Pirie	Haw. Agr. Expt. Sta., Honolulu, Oahu
		Victoria	Haw. Agr. Expt. Sta., Honolulu, Oahu
Mountain Apple	*Eugenia malaccensis*	No established varieties	Oahu
Orange	*Citrus sinensis*	Hawaiian	Kealakekua, Hawaii
Papaya	*Carica papaya*	No established varieties	Puuloa, Oahu
Passion-fruit	*Passiflora edulis*	Purple	Haw. Agr. Expt. Sta., Honolulu, Oahu
		Flavicarpa (Yellow)	Tantalus, Oahu
Pineapple	*Ananas sativus*	Smooth Cayenne	Robinson Section, Wahiawa, Oahu
Poha	*Physalis peruviana*	No established varieties	Kona, Hawaii
Soursop	*Annona muricata*	No established varieties	Haw. Agr. Expt. Sta., Honolulu, Oahu
Strawberry	*Fragaria chiliensis*	Unknown (New Carolina?)	Kaneohe, Oahu
Surinam-cherry	*Eugenia uniflora*	No established varieties	Haw. Agr. Expt. Sta., Honolulu, Oahu
Tamarind	*Tamarindus indica*	No established varieties	Punahou School, Honolulu, Oahu
Watermelon	*Citrullus vulgaris*	Chilean black-seeded	Oahu

TABLE 2.—*Proximate composition of Hawaiian fruits.*[5] *Edible portion.*

Name and variety of fruit	Water	Protein (N x 6.25)	Ether extract (Fat)	Crude fiber	Carbohydrate (by difference)	Ash	Acid as citric acid
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Avocado							
Hulumanu	82.8	1.4	9.3	1.5	4.2	0.79	0.10
Nabal	70.0	1.0	21.8	2.0	4.3	0.93	0.23
Banana							
Bluefields	71.1	1.5	0.2	0.6	25.8	0.80	0.36
Brazilian	67.0	0.9	0.3	0.7	30.3	0.76	0.52
Largo	65.7	0.9	0.3	0.4	31.9	0.77	0.64
Breadfruit							
Hawaiian	61.8	0.1	0.2	1.5	35.2	1.21	0.16
Carambola							
(juice only)	89.2	(0.1)*	(0.1)*	....	10.3	0.28	0.40
Coconut							
(water from nuts with no meat)	95.8	....	....	....	....	0.49	.....
(water from nuts with soft spoon meat)	93.8	....	....	....	....	0.41	.....
Fig							
Brown Turkey							
(whole)	85.7	0.7	0.2	0.9	12.1	0.41	0.15
(peeled)	85.4	0.6	0.3	0.9	12.5	0.33	0.17
Grape, Isabella							
(seeds removed)	81.1	0.4	0.2	0.6	17.3	0.38	1.93
(seeds and skins removed)	82.3	0.5	0.2	0.2	16.6	0.21	1.42
Guava, Common							
(whole)	81.8	0.7	0.2	7.0	9.8	0.50	1.37
(seeds removed)	84.9	0.3	(0.1)*	2.3	11.9	0.48	.....
("juice," watery extract)	93.9	0.1	....	....	5.7	0.34	0.88
Guava, Strawberry							
(whole)	81.7	0.5	0.4	6.1	10.7	0.61	1.62

[5] *For methods of analysis, see page 105.*

* *Estimated in order to supply carbohydrate figure.*

TABLE 2.—*Proximate composition of Hawaiian fruits. Edible portion. (continued)*

Name and variety of fruit	Water	Protein (N x 6.25)	Ether extract (Fat)	Crude fiber	Carbohydrate (by difference)	Ash	Acid as citric acid
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Litchi							
Hei Yeh	86.7	0.8	0.2	0.2	11.8	0.30	.....
Kwai Mi	77.6	0.9	0.3	0.2	20.6	0.37	.....
Mango							
Pirie	80.0	0.5	0.2	0.7	18.2	0.37	0.97
Victoria	81.5	0.5	0.2	0.6	16.9	0.33	.....
Mountain Apple	91.5	0.3	0.1	0.8	7.0	0.26	0.15
Orange, Hawaiian							
(with membrane)	87.8	0.7	0.1	0.5	10.6	0.41	1.16
(without membrane)	89.4	0.5	0.1	0.2	9.8	0.33	1.29
(juice)	90.1	(0.5)*	....	....	9.0	0.35	1.28
Papaya	85.6	0.5	0.3	0.8	12.3	0.51	0.13
Passion fruit							
Purple (juice only)	79.8	0.6	....	....	19.1	0.48	2.30
Pineapple							
Smooth Cayenne	85.6	0.5	0.2	0.5	12.9	0.28	0.48
(juice)	86.4	(0.3)*	....	....	13.0	0.27	0.59
Poha	81.7	1.9	0.1	3.2	12.2	0.87	0.89
Soursop	80.2	0.7	0.4	1.0	17.1	0.58	0.94
Strawberry	90.5	0.8	0.2	1.0	7.1	0.43	.....
Surinam-cherry	75.2	1.0	0.1	0.8	22.3	0.56	4.18
Tamarind	33.9	3.3	0.5	1.8	45.7†	2.57	12.16
Watermelon							
Chilean black seeded	90.2	0.9	0.1	0.1	8.3	0.37	0.09

* *Estimated in order to supply carbohydrate figure.*
† *Calculated as percent by difference including acids as citric.*

TABLE 3.—*Mineral composition of Hawaiian fruits.*[6] *Edible portion.*

Name and variety of fruit	Total Ash	Calcium (Ca)	Phosphorus (P)	Iron (Fe)
	Percent	Percent	Percent	Percent
Avocado, Hulumanu	0.79	0.008	0.034	0.00057
Nabal	.93	.011	.042	.00037
Banana, Bluefields	.80	.004	.023	.00027
Brazilian	.76	.007	.030	.00028
Largo	.77	.010	.035	.00135
Breadfruit, Hawaiian	1.21	.021	.048	.00026
Carambola (juice only)	0.28	.001	.012	.00007
Coconut (water from nuts with no meat)	.49	.026	.007	.00007
(water from nuts with soft spoon meat)	.41	.017	.013	.00007
Fig, Brown Turkey (whole)	.41	.028	.021	.00016
(peeled)	.33	.024	.022	.00015
Grape, Isabella (seeds removed)	.38	.012	.023	.00033
(seeds and skins removed)	.21	.008	.016	.00023
Guava, Common (whole)	.50	.010	.022	.00146
(seeds removed)	.48	.015	.016	.00030
("juice," watery extract)	.34	.006	.006	.00012
Guava, Strawberry (whole)	.61	.034	.020	.00028
Litchi, Hei Yeh	.30	.003	.032	.00021
Kwai Mi	.37	.004	.035	.00037
Mango, Pirie	.37	.006	.015	.00016
Victoria	.33	.005	.016	.00026
Mountain Apple	.26	.007	.013	.00038
Orange, Hawaiian (with membrane)	.41	.040	.024	.00020
(without membrane)	.33	.023	.020	.00020
(juice)	.35	.013	.020	.00018
Papaya	.51	.019	.013	.00025
Passion-fruit, Purple (juice only)	.48	.005	.018	.00034
Pineapple, Smooth Cayenne	.28	.018	.012	.00025
(juice)	.27	.016	.011	.00011
Poha	.87	.008	.059	.00093
Soursop	.58	.009	.030	.00038
Strawberry	.43	.021	.030	.00254
Surinam-cherry	.56	.015	.020	.00033
Tamarind	2.57	.113	.096	.00060
Watermelon, Chilean black seeded	0.37	.006	.017	.00017

[6] For methods of analysis, see page 107.

TABLE 4.—*Average weight and percentage of refuse of Hawaiian fruits. As purchased.*

Name and Variety of Fruit	Number of samples or measure	Average weight per fruit	Refuse	Portions of fruit considered as refuse
		Ounces	Percent	
Avocados, Hulumanu	9	22	27	skin and seed
Nabal	4	18	36	skin and seed
Bananas, Bluefields	12	5	34	skin
Brazilian	5	4	37	skin
Largo	24	5	33	skin
Breadfruit, Hawaiian	7	38	21	skin, stem and core
Carambolas	29	1.7	6	stem, blossom end, ribs and seeds
Carambola juice	280	1.7	34	skin, seeds and pulp
Coconuts, without husk	5	26	50	shell and water
Figs, Brown Turkey	18	2.6	13	skin
Grapes, Isabella	1 pound	6.0 per bunch	8	stem and seeds
	3 pounds		34	stem, skin and seed
Guavas, Common	12	2.8	3	stem and blossom end
	3	2.8	11	stem, blossom end and seeds
Strawberry	2½ pounds	0.3	3	stem and blossom end
Lime juice	38	1.5	61	skin, seeds and pulp
Litchi, Hei Yeh	3½ pounds	0.3	27	leaves, stem, shell and seed
Kwai Mi	3½ pounds	0.2	44	leaves, stem, shell and seed
Mangos, Pirie	10	7	43	skin and seed
Victoria	10	7	46	skin and seed
Mountain Apples	29	2.3	12	stem and seed
Oranges, Hawaiian	1 dozen	6	33	skin and seeds
	1 dozen	6	57	skin, seeds and membrane

TABLE 4.—*Average weight and percentage of refuse of Hawaiian fruits. As purchased (continued).*

Name and Variety of Fruit	Number of samples or measure	Average weight per fruit	Refuse	Portions of fruit considered as refuse
		Ounces	Percent	
Orange juice	1 dozen	6	58	skin, seeds and pulp
Papayas, Solo	6	15	30	skin, seeds and membrane
Large	25	3 pounds	25	skin, seeds and membrane
Passion-fruit, Yellow	10	2.8	42	shell, seeds and membrane
Yellow, juice	78	2.4	62	shell, seeds and pulp
Purple	86	1.3	51	shell, seeds and membrane
Purple, juice	86	1.3	71	shell, seeds and pulp
Pineapple, Smooth Cayenne with crown	10	4½ pounds	39	crown, core and parings
Pineapple juice	4	4½ pounds	53	crown, core, paring and pulp
Pohas	6 separate 1 pound samples		7	husk and stem
Soursops	19	1¾ pounds	34	skin and seeds
Soursop juice	19	1¾ pounds	47	skins, seeds and pulp
Strawberries	1 pound	1.6	3	stem and cap
Surinam-cherries	5 samples Total wt. 3 pounds	0.14	26	stem, blossom end and seeds
Tamarinds	1 pound	0.5	69	pod and seeds
Watermelons	2	18¾ pounds	36	rind and seeds

TABLE 5.—*Average measure and cost of Hawaiian fruits per pound. As purchased and edible portion.*

Name and Variety of Fruits	Measure per pound As Purchased	Measure per pound Edible Portion*	Approximate cost per pound	
			As Purchased	Edible Portion
Avocados, Hulumanu	¾ large	1 large	$0.10	$0.13
Nabal	1 large	1⅓ cups pulp; 2¾ cups, sliced	.10	.14
Bananas, Bluefields	2⅔ large	1⅓ cups pulp	.04	.05
Brazilian	4¼ medium; 3¾ large	6¼ medium; 1½ cups pulp	.05	.07
Largo	2⅔ medium	4 medium	.06	.08
Breadfruit, Hawaiian	⅔ medium	2 cups pulp	.05	.06
Carambolas	17 small	18⅔ small		
Carambola juice		2 cups		
Coconuts	½ medium (without husk)	4¼ cups, grated	.08	.11
Figs, Brown Turkey	6¼ medium	7¼ medium; 2⅔ cups, ¼-inch slices (without skin)	.15	.17
Grapes, Isabella	4 medium bunches	2 cups (without stems and seeds)	.15	.16
		1½ cups (without stems, skins and seeds)	.15	.21
Guavas, Common	5¾ medium	2 cups, sliced (with seeds)		
		2 cups pulp, (without seeds)		
Guavas, Strawberry	51 fruit; 3 cups	54 fruit; 3⅓ cups, whole		
Lime juice	16 medium	1¾ cups	.16	.26
Litchi, Hei Yeh	30 large	2 cups, 42 large	.65	.88
Kwai Mi	40 medium	1¾ cups, 72 medium	.65	1.14
Mangos, Pirie	2⅓ medium	4¼ medium	.15	.26
Victoria	2¼ medium	4¼ medium	.05	.07

* For portions of fruit considered as refuse see Table 4, page 93.

TABLE 5.—*Average measure and cost of Hawaiian fruits per pound. As purchased and edible portion.*

Name and Variety of Fruits	Measure per pound As purchased	Measure per pound Edible Portion*	Approximate cost per pound	
			As Purchased	Edible Portion
Mountain Apples	5 medium	2¼ cups, ½-inch cubes	.09	.10
Oranges, Hawaiian	2½ medium	3¾ medium, 2¾ cups pulp (with membrane)	.04	.06
		5¾ medium, 2½ cups pulp (without membrane)	.04	.07
Orange juice		2 cups	.04	.07
Papayas, Solo	1 fruit, medium	1⅓ cups pulp; 2½ cups ½-inch cubes	.06	.07
Large	⅓ medium	1½ cups pulp; 2½ cups ½-inch cubes	.03	.03
Passion-fruit, Yellow	5¾ medium; 7⅔ small	1¾ cups pulp	.13	.19
Passion-fruit juice		2 cups	.13	.22
Pineapples, Smooth Cayenne	¼ fruit (with crown)	2 cups, ½-inch cubes	.03	.04
Pineapple juice		1¾ cups	.03	.04
Pohas	5⅓ cups	2½ cups, whole	.13	.13
Soursops	⅔ medium fruit	2 cups pulp	.05	.07
Soursop juice		1¾ cups	.05	.07
Strawberries	4½ cups	3⅓ cups, whole	.37	.38
Surinam-cherries	3⅜ cups medium fruit	4⅓ cups		
Tamarinds	32 fruit	1½ cups pulp		
Watermelons	1 sector { 9½ in. diameter 1½ in. at circumference }	3 cups, ½-inch cubes	.05	.06

* For portions of fruit considered as refuse see Table 4, page 93.

TABLE 6.—*Weight, measure and cost of one hundred calorie portions of Hawaiian fruits. Edible portion.*

Name and Variety of Fruit	Measure	Weight in grams	Approximate cost*
Avocado, Hulumanu	¼ medium	94	$0.026
Nabal	¾ medium	46	.014
Banana, Bluefields	¾ medium		
	5⅔ tbs. pulp	90	.011
Brazilian	1 medium		
	¼ cup pulp	78	.012
Largo			
(uncoooked)	½ medium		
	⅓ cup pulp	74	.013
(baked)	½ medium		
	¼ cup pulp	57	.013
Breadfruit, Hawaiian			
(uncooked)	¼ cup pulp	70	.010
(baked) *(34)*†	⅓ cup pulp	84	.010
Carambola (juice only)	1 cup	238	
Coconut *(34)*†	2 tbs., grated fine	17	.004
Fig, Brown Turkey			
(whole)	2⅔ medium	189	.063
(peeled)	3 medium—¾ cup, sliced	182	.068
Grape, Isabella			
(skins and seeds removed)	½ cup	143	.065
(seeds removed)	⅔ cup	137	.050
Guava, common			
(whole)	3 guavas—1¼ cups, sliced	228	
(seeds removed)	1 cup	200	
("juice," watery extract)	2 cups	435	
Guava, strawberry			
(whole)	22 guavas, 1-inch dia., 1¼ cups	204	

* See Table 5 for cost per pound.
† See Literature Cited.

TABLE 6.—*Weight, measure and cost of one hundred calorie portions of Hawaiian fruits. Edible portion. (Continued)*

Name and Variety of Fruit	Measure	Weight in grams	Approximate cost*
Lime (juice only)	1½ cups	301	.366
Litchi, Hei Yeh	23 litchis, 1¼ cups	192	.375
Kwai Mi	20 litchis, ½ cup	112	.285
Mango, Pirie	⅔ cup, sliced	130	.074
Victoria	¾ cup, sliced	139	.023
Mountain Apple	4 medium		
	2 cups, ½-inch cubes	334	.073
Orange, Hawaiian			
(with membrane)	1¾ medium, 1⅓ cups sections	217	.027
(without membrane)	2⅓ medium, 1⅓ cups sections	238	.037
(juice)	1¼ cups	263	.044
Papaya	1 cup, ½-inch cubes		
	½ cup pulp	185	.013
Passion-fruit (juice only)	½ cup	128	.062
Pineapple, Smooth Cayenne			
(peeled)	2 slices, ¾-inch thick		
	1 cup, ½-inch cubes	179	.014
(juice)	¾ cup	189	.016
Poha	63 pohas, 2 cups	173	.051
Soursop, (pulp)	½ cup	133	.010
(juice)	1 cup	248	.050
Strawberry	2¼ cups, whole	303	.253
Surinam-cherry	39 cherries, ½ cup	106	
Tamarind	2¾ tbs.	50	
Watermelon, Chilean			
black seeded	1⅔ cups, ½-inch cubes	263	.036

* See Table 5 for cost per pound.

TABLE 7.—*Distribution of calories per 100 grams and calories per pound. Edible portion.*

Name and variety of fruit	Calories per 100 grams				Calories per Pound
	Protein	Fat	Carbohydrate	Total	
	Cals.	Cals.	Cals.	Cals.	Cals.
Avocado, Hulumanu	6	84	17	107	486
Nabal	4	196	17	217	986
Banana, Bluefields	6	2	103	111	504
Brazilian	4	3	121	128	582
Largo	4	3	128	135	613
Breadfruit, Hawaiian	0.4	2	141	143	650
Carambola (juice only)	0	1	41	42	191
Fig, Brown Turkey (whole)	3	2	48	53	241
(peeled)	2	3	50	55	250
Grapes, Isabella (seeds removed)	2	2	69	73	331
(seeds and skins removed)	2	2	66	70	318
Guava, Common (whole)	3	2	39	44	200
(seeds removed)	1	1	48	50	227
("juice," watery extract)	0	0	23	23	104
Guava, Strawberry (whole)	2	4	43	49	222
Litchi, Hei Yeh	3	2	47	52	236
Kwai Mi	4	3	82	89	404
Mango, Pirie	2	2	73	77	350
Victoria	2	2	68	72	327
Mountain Apple	1	1	28	30	136
Orange, Hawaiian (with membrane)	3	1	42	46	209
(without membrane)	2	1	39	42	191
(juice)	2	0	36	38	173
Papaya	2	3	49	54	245
Passion-fruit, Purple (juice only)	2	0	76	78	354
Pineapple, Smooth Cayenne (without peel and core)	2	2	52	56	254
(juice)	1	0	52	53	241
Poha	8	1	49	58	263
Soursop	3	4	68	75	341
Strawberry	3	2	28	33	150
Surinam-cherry	4	1	89	94	427
Tamarind	13	5	183	201	913
Watermelon, Chilean black seeded	4	1	33	38	173

TABLE 8.—*Quantity of juice obtained from 1 pound of fruit. As purchased.*

Name and variety of fruit	Water added	Yield of Juice	
		measure	weight
	cups	cups	ounces
Carambola		1¼	10
Coconut (water from nuts with no meat)		2	18
Guava, Common (for jelly)	1½	1⅔	14
(for juice)	1	1½	13
Guava, Strawberry (ripe)	1¼	1½	12
Grape, Isabella (for jelly)	⅔	1⅓	12
Lemon		½	4
Lime		⅔	6
Orange, Hawaiian		1	8
Passion-fruit		⅔	6
Pineapple		¾	7
Poha	⅓	1	8
Soursop		1	9
Surinam-cherry		1	9

TABLE 9.—*Hawaiian fruits as sources of vitamins.*[7]

The Key to the Symbols is as Follows:

\+ indicates that the food contains the vitamin.
++ indicates that the food is a good source of the vitamin.
+++ indicates that the food is an excellent source of the vitamin.
— indicates that the food contains no appreciable amount of the vitamin.
* indicates that evidence is lacking or appears insufficient.

Fruit	Vitamin A	Vitamin B	Vitamin C	Vitamin G
Avocados	++	++	++	++
Bananas	++	+	++	+
Breadfruit	+	+	+	*
Coconut water	—	+	+	++
Figs, whole	+	+	+	+
Grapes	+	+	+	+
Guava, common				
seeds removed	++	++	+++	+
jelly	—	*	+++	*
"juice"	*	*	+++	*
Lemon juice	+	++	+++	++
Lime juice	—	*	++	*
Mangos	++	+	++	++
Mountain apples	+	+	+	+
Orange juice	+	++	+++	++
Papayas	+++	+	+++	+
Passion-fruit juice	*	*	+++	*
Pineapple				
fresh fruit	+	+	++	+
fresh juice	*	*	++	*
Pohas	+++	++	+++	+ to ++
Soursop juice	*	++	++	*
Strawberries	+	+	++	*
Tamarinds	—	+++	?	*
Watermelon	+	+	++	+

[7] The sources of information for the ratings in this table are experimental work reported in this bulletin, literature cited, or personal communication from Hazel E. Munsell, in charge, Nutrition Studies Section, Bureau of Home Economics, U. S. D. A.

TABLE 10.—*Vitamin values of some Hawaiian fruits in approximate units per 100 grams. Edible portion.*

(Standards used are listed below)

Fruit	Vitamin A	Vitamin B	Vitamin C	Vitamin G
Coconut water			5	
Figs, whole	80	10	5	33
Guava, seeds removed	200	14	300	35
jelly			60	
juice			100	
Orange juice			60	
Papaya	2500	8	70	33
Passion-fruit juice			50	
Pineapple, pulp	100	25		23
juice			20	
Pohas	4000	50	50	50
Soursop juice		15	10	
Tamarind		100		

Vitamin A—International standard
1 unit=0.6 gamma (0.0006 milligram) beta carotene.

Vitamin B—International standard
1 unit=0.01 gram activated kaolin (page 108).

Vitamin C—Sherman's standard
1 unit=minimum daily quantity that protects from gross scurvy.

Vitamin G—Sherman's standard
1 unit=minimum daily quantity that permits an average gain of 3 grams per week.

TECHNICAL SECTION

Preparation of Fruit for Chemical Analysis

Note: All analytical determinations were made on the "edible portion," which may be described as that part of the fruit remaining after removal of the refuse as noted on page 93. Unless otherwise stated, all samples were taken from thoroughly mixed, fresh material without previous drying, representing a number of fresh ripe fruits. To prevent contamination with iron or other extraneous material, a stainless steel knife and a hard rubber chopping board were used in the preparation of all fruit samples.

Avocados, Hulumanu—The fruit was cut in half, the seed removed, and the flesh peeled and mashed with a silver fork.

Avocados, Nabal—The fruit was prepared in the same way as the Hulumanu variety. All determinations were made on fresh material except the ether-extract determinations, which were made on material which had been dried before the samples were weighed out.

Bananas, Bluefields and Brazilian—The fruit was peeled and any adhering fibrous material was removed. The pulp was mashed with a silver fork.

Bananas, Largo—The fruit was peeled and, after the adhering fibrous material had been removed, was chopped. The material for the iron determinations was not chopped but mashed with a glass rod.

Breadfruit, Hawaiian—The peel and core were discarded and the flesh was chopped.

Carambolas (juice)—The fruit was cut in pieces and the juice expressed through 6 thicknesses of cheesecloth. The specific gravity of the juice was determined and samples were obtained by pipetting definite quantities of the juice.

Coconuts (water)—The top of the coconut husk was chopped off with a hatchet until the shell was reached. As the shell was quite soft, a small piece of it was cut away and the water within the nut was siphoned off through a glass tube into a large glass breaker.

Figs, Brown Turkey (whole)—Thoroughly ripe figs were carefully selected and washed with distilled water. After the excess water had been removed with clean cheesecloth, the fruit was chopped.

Figs, Brown Turkey (peeled)—Ripe whole figs were peeled and chopped.

Grapes, Isabella (seeds removed)—The fruit was prepared by cutting the grapes in half and removing the seeds with ivory-tipped forceps. The samples used for the iron determinations were ashed without drying. The remaining samples were taken from material which had been cut into small pieces with a pair of scissors and dried at a low temperature for several days.

Grapes, Isabella (skins and seeds removed)—The fruit was squeezed from the skin and the seeds removed with irovy-tipped forceps. The pulp was shredded with a silver fork. The samples used for the iron analyses were ashed without drying. The remaining samples were taken from materials which had been dried at a low temperature for several days.

Guavas, Common (whole)—Ripe firm guavas were carefully selected. The stem and blossom end were removed and the remainder chopped. The material for the iron determinations was not chopped but consisted of representative slices cut from several guavas.

Guavas, Common (seeds removed)—The material used for the determinations was not a composite of a number of fruits. A lengthwise section of a fruit was taken for each determination, the seeds carefully removed and cleaned of all adhering flesh before they were discarded.

Guavas, Common (juice)—The juice analyzed was that prepared for the feeding of infants (p. 36).

Guavas, Strawberry—The fruit was prepared in the same way as the whole comon guavas.

Litchis, Hei Yeh and Kwai Mi—The shell and the seed of the fruit were discarded and, for all the determinations except iron, the flesh was dried for several days at a low temperature. The samples used for the iron determinations were ashed without drying.

Mangos, Pirie and Victoria—The fruit was peeled, the seed removed and the flesh sliced and chopped.

Mountain Apples (36).

Oranges, Hawaiian (with and without membrane)—The samples used for analyses were unchopped sections of the oranges, with and without the surrounding membrane. As it was impossible to chop or mash the sections without losing comparatively large quantities of juice, a composite sample was not prepared. Where more than one section was used, they were taken from several different fruits.

Oranges, Hawaiian (juice)—The oranges were cut in half. A large glass orange squeezer of the household type was used to extract the juice which was strained through a 10-mesh copper screen.

Papayas—The fruit was cut in half and the seeds and membrane removed with a silver spoon. The flesh was peeled and mashed with a silver fork.

Passion-fruit (juice)—The fruit was cut in half and the pulp and seeds removed from the shell with a silver spoon. The juice was expressed by squeezing the pulp and seeds in four thicknesses of cheesecloth.

Pineapples, Smooth Cayenne—The fruit was peeled and the flesh surrounding the core was diced and used for analysis.

Pineapples (juice)—The fruit was peeled and the core cut out. The flesh was cut into large pieces and the juice was extracted by squeezing in four thicknesses of cheesecloth.

Pohas—The husks of the fruit were removed and each was wiped with clean cheesecloth. The samples for all determinations, except iron, were taken from material which had been dried for several days at low temperature and ground in a glass mortar. Fresh material without previous drying was ashed for the iron determinations.

Soursops—The skin and seeds were discarded and the flesh was prepared in the same way as that of mangos.

Strawberries—The fruit was carefully washed and the caps discarded. The pulp was prepared for analysis by chopping.

Surinam-cherries—The cherries were carefully selected and wiped with clean cheesecloth. The stems, seeds and blossom ends were discarded and the flesh used without further treatment.

Tamarinds—After removing the shell from the fruit, the sticky pulp was scraped from the seeds and mixed well.

Watermelons, Chilean black seeded—The watermelons were peeled and the seeds removed. The flesh was diced and used for analysis.

Methods of Chemical Analysis

All analyses except those for calcium and iron were carried out by methods of the Association of Official Agricultural Chemists *(1)*. For the water determinations a slight modification was made as described under "Water" (p. 106). The methods used for the determination of calcium and of iron are standard methods and are described under the titles "Calcium" (p. 107) and "Iron" (p. 107). All determinations were done in triplicate, and most of the figures in the table are averages of three determinations. In a few cases, they represent the average of the two figures which agree best or the average of analyses on two separate samples of fruit. Refuse was determined as percentages of the fruit "as purchased." All other determinations were calculated as percentages of the edible portion.

Refuse

The difference in weight between the fruit "as purchased" and the "edible portion" is called the refuse and is expressed as a percentage of the fruit "as purchased." The fruit was wiped with a piece of dry, clean cheese cloth and the total weight of the sample to be used was recorded. The refuse was then removed and placed in a tared beaker and weighed. When it was necessary to remove the skin by peeling, a stainless-steel knife was used. The parts considered refuse and the percentages of refuse may be found in Table 4.

Titratable acidity

The acid of the fruit as given in Table 2 represents the total free

acid as determined by titration against standard alkali using phenolphthalein as indicator. It is expressed as anhydrous citric acid and is calculated as a percentage of the fresh edible material.

Water

The loss in weight of the edible portion of the fruit after drying is called the water content, or moisture content, of the fruit. This is expressed as percentage of the edible portion. A modification of the method of the Association of Official Agricultural Chemists was adopted. A thin layer of fresh, edible material was weighed in a small, shallow weighing bottle, (30 by 45 mm.). Since fruits usually contain appreciable amounts of sugars which are lost at a temperature approaching 100° C., the samples were dried at a temperature of 65° C. for a period of three days. This was low enough to prevent any but the slightest charring of the sugars and at the same time to dry the sample thoroughly. The final traces of moisture were removed by leaving the samples *in vacuo* over sulphuric acid for three days.

Protein
(Nitrogen x 6.25)

The protein content of the fruit was calculated as nitrogen x 6.25, estimating that all of the nitrogen of the fruit is protein nitrogen and that it constitutes 16 percent of the protein. The nitrogen was determined by the Gunning modification of the Kjeldahl method.

Ether extract

The ether extract represents that portion of the fruit which is soluble in ethyl ether (C.P. anhydrous, distilled over sodium). In many tables this is classed as fat; but because it includes other substances such as waxes, resins and plant pigments, and because in most fruits the percentage is very small, it is probably better called ether extract.

Crude fiber

The crude fiber of the fruit represents that portion of the fruit which remains after extraction of the dried material with ether, and after boiling with dilute sulphuric acid and then with dilute sodium hydroxide, but which is lost on ignition. It is considered to be that portion which is not utilized during digestion.

Carbohydrate by difference

The carbohydrate figures given in Table 2 represent all carbohydrates except crude fiber. These include polysaccharides and all sugars, some of which may not be utilized in the body. The figures were obtained by subtracting the sum of the percentages of water, protein, ether extract, crude fiber and ash from 100. This method of determining carbohydrates involves an error, the greatness of which depends upon the quantity of other undetermined substances, such as pectins, pentosans and organic acids that may be present.

Total ash

The ash content of the fruit is the residue which remains after burning the substance until it is free from carbon.

In most cases the material was ashed in the fresh state. Each sample was weighed directly into a weighed silica dish containing a piece of ashless filter paper, which protects the bottom of the dish from the action of acid and minerals.

Aliquots of the solution of the ash were used for the determination of calcium and phosphorus in every case and for iron in those cases in which the method of preparation of the sample precluded iron contamination.

Calcium

The calcium content of the fruit was determined by a slight modification of the McCrudden volumetric method *(61)*.

Phosphorus

To determine the phosphorus content of the fruit the ammonium phosphomolybdate volumetric method was used.

Iron

The iron content of the fruit was determined by the method of Elvehjem and Hart *(13)*. A blank was run with each group of analyses, and the iron found in the blank was subtracted from the total iron found in the fruit. The samples were ashed in a closed electric muffle, without previous drying, and every care was taken to prevent any iron contamination.

Methods of vitamin determinations

All experimental animals were raised in the station laboratory. The mothers of all experimental rats received the following diet: whole wheat 960 grams, whole milk powder 400 grams, cooked soybean meal 100 grams, dried yeast 65 grams, wheat germ 40 grams, sodium chloride 10 grams, salt mixture 10 grams. The salt mixture was made up of 9 parts calcium carbonate and 1 part ferric citrate.

All experimental animals were kept in individual cages with raised screen bottoms, and were allowed distilled water and the basal diets *ad libitum*.

Unless otherwise noted, the fruits were prepared for feeding in the same manner as for analysis. Pohas were used fresh and not dried. The fruits were not finely chopped or mashed as for the analyses but representative samples of such fruits as papayas, figs and pohas were always taken.

Vitamin A: For the vitamin A experiments, young rats were weaned at about 3 weeks of age and placed on the following experimental diet: extracted casein *(62, p. 257)* 18 percent, dried yeast (Northwestern) 10 percent, salt mixture *(42)* 4 percent, sodium chlo-

ride 1 percent, cornstarch 57 percent, Crisco 10 percent, viosterol to supply 1 part in 40,000 parts of diet.

Despite the fact that the young rats were placed on the A-free diet at from 19 to 21 days of age, when they weighed an average of 41 grams, they made large gains before the vitamin A stores were depleted, reaching an average weight of 124 grams. The average time of depletion was 31 days. Previous experiments showed that rats fed 3 units of carotene (International Standard) per day (6 days a week) suffered such high mortality that 4 units was chosen as the standard of comparison. Rats fed this quantity of carotene, and even those fed 3 units, if they survived, showed such great increments in weight that the results cannot be compared with the recommended Sherman standard—a gain of 3 grams per week *(62, p. 265)*.

After the depletion of vitamin A stores the rats were fed the supplementary foods for 5 or 6 weeks. From each litter of rats were chosen 1 negative control which was continued on the basal diet only and 2 or more positive controls which were fed 4 units of the 1931 International Standard carotene (1 unit is equivalent to 0.6 gamma of carotene). With few exceptions there was good distribution of the sexes within the various groups—positive and negative controls and animals fed the fruits. Daily feedings (i.e., every day except Sunday) were given in the case of most fruits; carotene was fed 2 times a week, papaya and pohas 3 times a week. For all vitamin tests of the fruits, quantities of 2 grams or more were weighed on a Torsion balance and quantities less than 2 grams on a chainomatic balance. The results of feeding carotene, figs, guavas, papayas, pineapples or pohas as the sole source of vitamin A are summarized in Table 11 and Figure 14.

Vitamin B: For the vitamin B experiments, young rats were weaned at from 17 to 18 days of age and continued on the breeding diet to 21 days, when they averaged 40 grams in weight. They were then placed on the following diet: extracted casein *(62, p. 100)* 18 percent, salt mixture 4 percent, cod liver oil 2 percent, butter fat 8 percent, cornstarch 53 percent, autoclaved yeast (Northwestern yeast autoclaved at 15 lbs. pressure for 5 hours) 15 percent. The average time for depletion was 23 days when the rats weighed on the average 72 grams. From each litter of rats were chosen 1 or more negative controls which were continued on the basal diet only and 2 or more positive controls which were fed 0.005 gram of the 1931 International Standard (0.010 gram of the International Standard is equivalent to 1 unit. The standard is a concentrated preparation of the anti-neuritic vitamin, adsorbed on kaolin from a watery extract of rice polishings and subsequently dried). Supplements of fruits were fed daily except Sunday. The International Standard was fed as 0.01 gram three times a week. Table 12 and Figure 15 summarize the results of feeding the International Standard, figs, guavas, papayas, pineapples, soursops or tamarinds as the sole source of vitamin B.

Vitamin G (B_2): For the vitamin G experiments, young rats were weaned at from 17 to 18 days and continued on the breeding diet an average of 22 days, when they averaged 43 grams in weight. They were

placed on the following diet: extracted casein *(62, p. 100)* 18 percent, salt mixture 4 percent, cod liver oil 2 percent, butter fat 8 percent, cornstarch 68 percent. The average time for depletion was 24 days, when the rats weighed an average of 49 grams. For these experiments, vitamin B was supplied the rats by feeding daily either 4 drops (0.12 to 0.13 gram) of tikitiki extract obtained from the Bureau of Science, Manila, P. I., or an extract of tikitiki made in the nutrition laboratory. The latter was prepared so that 0.1 cc., which was fed daily, was equivalent to 1 gram of rice bran.

From each litter of rats were chosen 2 or more negative controls which were continued on the basal diet only and, except in the case of guavas, 2 or more positive controls which were fed 0.1 gram of autoclaved yeast.

Because no International Standard has been chosen for vitamin G experiments and in order to have some uniform basis for comparison, 0.1 gram of autoclaved yeast was arbitrarily chosen as a standard. The results of feeding this quantity of yeast to positive controls were remarkably uniform (Table 13), the average gain of 20 rats for 5 weeks being 23 grams.

Supplements of the fruits and autoclaved yeast were fed daily except Sunday. Table 13 and Figure 15 summarize the results of feeding autoclaved yeast, figs, guavas, papayas, pineapples or pohas as the sole source of vitamin G.

Vitamin C: Standard guinea pigs raised in our laboratory were used to test the vitamin C potency of the fruits. The guinea pigs were fed Sherman's *(62, p. 169)* scorbutic basal diet plus fresh alfalfa plus the supplements until they ate the fruits or fruit juices readily. The alfalfa was then discontinued and the supplements fed to the guinea pigs for the periods recorded in Table 14.

Negative controls were not used for every group of guinea pigs fed on a particular fruit but were used at intervals and in some cases one group of guinea pigs fed a poor antiscorbutic served as controls for those fed a good antiscorbutic. All fruits were fed daily except Sunday. All juices and coconut water were accurately measured and fed by means of a glass hypodermic syringe with a small rubber tip. The International Standard, ascorbic acid, was not yet available for use when these tests were made.

At the end of the experiments the histological examination of the incisor teeth recommended by Höjer *(21)* was employed. The results of the experiments are summarized in Table 14.

TABLE 11.—*Results of feeding various amounts of fruits to rats as the sole source of vitamin A.*

Vitamin studied and source	Rats	Weight of supplement fed daily	Average Weights			Average gain in 6 weeks
			Initial	When supplement started	Final	
	Number	Grams	Grams	Grams	Grams	Grams
Vitamin A:						
Negative Control	3	0.0	45	124†	82	.....
Carotene	4	4 units	43	111	173	62
Figs	10	5.0	43	118	197	79
Negative Control	4	0.0	40	119†	85	.....
Carotene	7	4 units	37	118	225	107
Guavas (seeds removed)	9	1.0	39	114	165	51
" " "	9	2.0	38	133	222	89
Negative Control	5	0.0	41	124†	90	.....
Carotene*	9	4 units	48	126	206	80*
Papaya*	12	0.1	43	120	186	66*
Negative Control	5	0.0	42	127†	87	.....
Carotene	8	4 units	36	125	210	85
Pineapple	9	2.0	40	120	151	31
"	6	3.0	37	124	199	75
Negative Control	3	0.0	42	123†	78	.....
Carotene	8	4 units	44	132	215	83
Pohas*	4	0.1	43	145	222	77*
Pohas	9	0.2	44	140	243	103

† Weight at the end of the depletion period.
* All rats in this group fed 5 weeks.

TABLE 12.—*Results of feeding various amounts of fruits to rats as the sole source of vitamin B.*

Vitamin studied and source	Rats	Weight of supplement fed daily	Average Weights			Average gain in 6 weeks
			Initial	When supplement started	Final	
	Number	Grams	Grams	Grams	Grams	Grams
Vitamin B:						
Negative Control	2	0.0	42	72†	48	.....
Standard	4	0.005	41	72	107	35
Figs	7	4.0	40	75	101	26
Negative Control	3	0.0	39	68†	53	.....
Standard	5	0.005	37	73	107	34
Guavas (seeds removed)	13	4.0	36	70	110	40
Negative Control	5	0.0	38	68†	49	.....
Standard	9	0.005	40	70	130	60
Papaya	14	6.0	41	72	126	54
Negative Control	3	0.0	37	62†	43	.....
Standard	4	0.005	36	67	106	39
Pineapple	16	2.0	45	73	110	37
Negative Control	3	0.0	35	72†	46	.....
Standard	5	0.005	34	67	100	33
Pohas	7	1.0	35	72	108	36
Negative Control	1	0.0	68	90†	54	.....
Soursop	4	3.0	66	84	122	38
"	4	4.0	65	85	140	55
Negative Control	3	0.0	35	69†	49	.....
Standard	6	0.005	34	65	104	39
Tamarind, new*	7	1.0	38	73	144	71
" , old	6	1.0	37	74	144	70

* "New" indicates fresh 1935 crop, "old" indicates pulp removed from the pod and kept at 36°-38° F for one year.

† Weight at the end of the depletion period.

TABLE 13.—*Results of feeding various amounts of fruits to rats as the sole source of vitamin G.*

Vitamin studied and source	Rats	Weight of supplement fed daily	Average Weights			Average gain in 5 weeks
			Initial	When supplement started	Final	
	Number	Grams	Grams	Grams	Grams	Grams
Vitamin G:						
Negative Control	9	0.0	48	52	55	3
Autoclaved yeast	3	0.1	41	44	68	24
Figs	10	3.0	45	54	71	17
Negative Control	2	0.0	48	57	58	1
Guavas, (seeds removed)	13	2.0	48	57	68	11
Negative Control	5	0.0	40	47	52	5
Autoclaved yeast	5	0.1	37	43	67	24
Papaya	8	2.0	51	58	66	8
"	16	3.0	44	50	67	17
Negative Control	8	0.0	37	44	47	3
Autoclaved yeast	6	0.1	37	43	68	25
Pineapple	14	6.0	36	43	64	21
Negative Control	5	0.0	40	46	49	3
Autoclaved yeast	6	0.1	40	46	67	21
Pohas	11	2.0	39	43	57	14

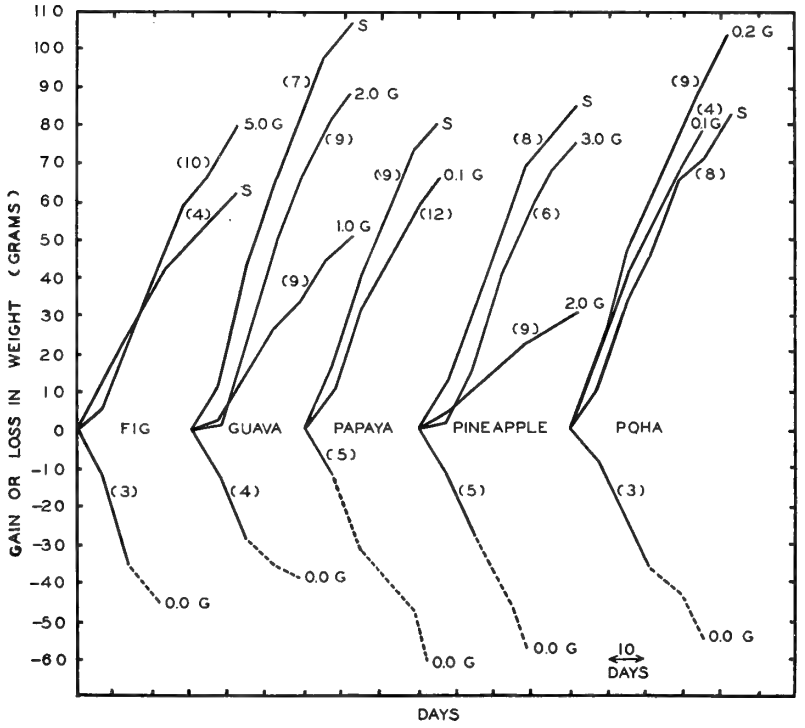

FIGURE 14.—Average gain in weight of groups of young rats fed various amounts of fresh fruits and carotene as the sole source of vitamin A. S=4 units of International Standard carotene. The broken line indicates the occurrence of the first death in the control group. The numbers in parentheses show the number of rats used for each test.

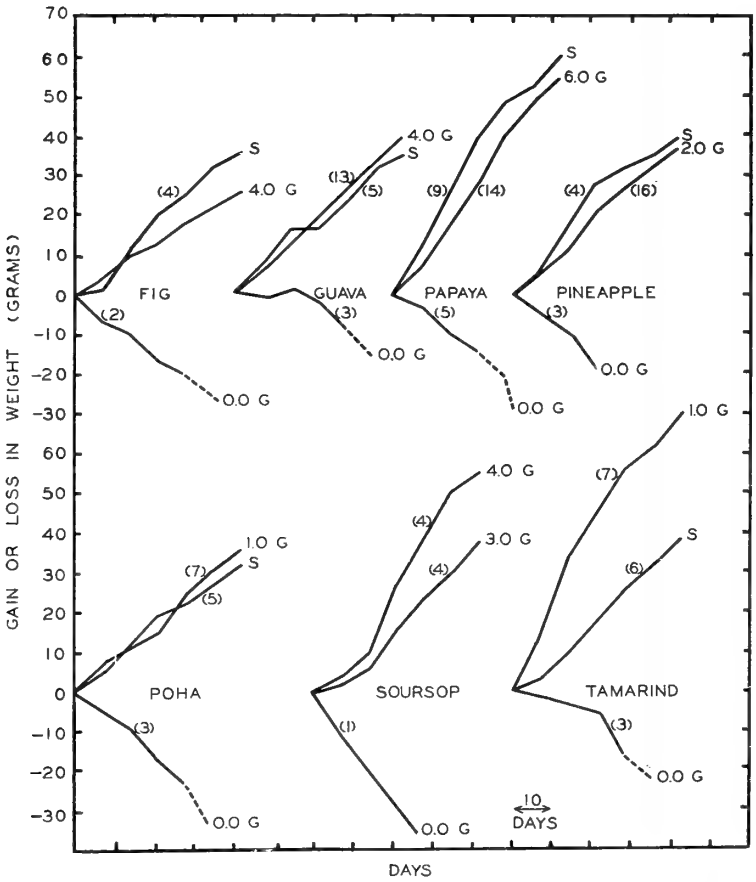

FIGURE 15.—Average gain in weight of groups of young rats fed various amount of fresh fruits and activated kaolin as the sole source of vitamin B. S=0.005 gram of the International Standard. The broken line indicates the occurrence of the first death in the control group. The numbers in parentheses show the number of rats used for each test.

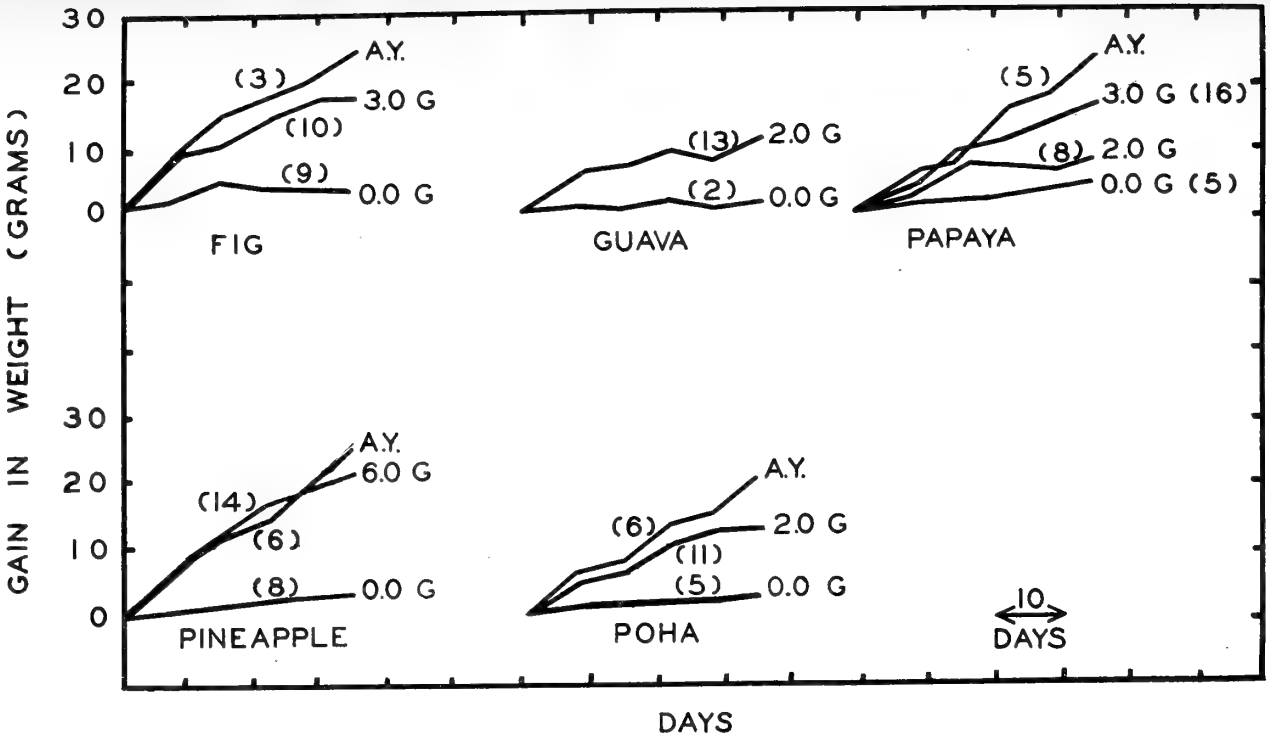

FIGURE 16.—Average gain in weight of groups of young rats fed various amounts of fresh fruits and autoclaved yeast as the sole source of vitamin G (B_2). The numbers in parentheses show the number of rats used for each test. A.Y.=0.1 gram autoclaved yeast.

TABLE 14.—*Results of feeding various amounts of Hawaiian fruits and fruit juices to guinea pigs as the sole source of vitamin C.*

Guinea Pig No.	Kind and quantity of supplement fed daily	Period during which supplement was fed	Weight of Animals		Net gain or loss	Gross scurvy at autopsy[1]	Histological examination of teeth, Höjer's rating[2]
			When supplement started	At end of experiment			
		Days	Grams	Grams	Grams		
232 F	Negative control—0 grams	20[3]	306[3]	388	82	++	0.0
323 M	Negative control—0 grams	21	303	154	—149	+++	....[4]
335 M	Negative control—0 grams	21	323	336	13	++	0.0
348 F	Negative control—0 grams	21	304	177	—127	++	0.0
375 M	Negative control—0 grams	21	330	335	5	++	0.0
381 M	Negative ontrol—0 grams	24	343	224	—119	+++	0.0
408 F	Negative control—0 grams	21	313	318	5	++	0.2
410 F	Negative control—0 grams	21	301	257	—44	++	0.0
459 M	Negative control—0 grams	21	300	304	4	++	0.2
414 F	Coconut water— 5 cc.	21	300	343	43	tr	0.2
443 M	Coconut water—5 cc.	21	321	384	63	+	0.4
445 M	Coconut water—5 cc.	21	300	399	—1	+	0.2
447 M	Coconut water—5 cc.	21	312	406	94	tr	0.2
451 M	Coconut water—5 cc.	21	318	401	83	+ to tr	0.2
404 F	Coconut water—10 cc.	21	300	290	—10	++	0.0
406 F	Coconut water—10 cc.	21	302	285	—17	++	0.0
412 F	Coconut water—10 cc.	21	300	334	34	+	0.2
416 F	Coconut water—10 cc.	21	304	327	23	++	0.0
435 M	Coconut water—10 cc.	21	312	352	40	+	0.2
437 M	Coconut water—10 cc.	21	312	374	62	tr	0.4
439 M	Coconut water—10 cc.	21	300	390	90	tr	0.4
441 M	Coconut water—10 cc.	21	304	388	84	tr	0.4

[1] Sherman, H. C., and Smith, S. L. *(62)*.

[2] Höjer, A. *(21)*.

[3] For negative controls, figures represent number of days basal diet was fed and weight when basal diet was started.

[4] Histological preparation unsatisfactory.

TABLE 14.—*Results of feeding various amounts of Hawaiian fruits and fruit juices to guinea pigs as the sole source of vitamin C. (Continued)*

Guinea Pig No.	Kind and quantity of supplement fed daily	Period during which supplement was fed	Weight of Animals		Net gain or loss	Gross scurvy at autopsy	Histological examination of teeth, Höjer's rating
			When supplement started	At end of experiment			
		Days	Grams	Grams	Grams		
436 F	Coconut water—20 cc.	21	347	363	16	?	0.4
440 F	Coconut water—20 cc.	21	309	350	41	tr	0.4
461 M	Coconut water—20 cc.	21	329	320	—9	—	0.4
463 M	Coconut water—20 cc.	21	324	352	28	—	0.5
340 F	Figs, whole—10 grams	21	302	236	—66	+++	0.0
342 F	Figs, whole—10 grams	21	308	323	15	+	0.2
344 F	Figs, whole—10 grams	21	313	269	—44	++	0.0
369 M	Figs, whole—10 grams	21	303	256	—47	+++	0.0
371 M	Figs, whole, 10 grams	21	307	379	72	—	0.4
257 M	Guava, with seeds—1 gram	21	349	451	102	—	1.0
261 M	Guava, with seeds—1 gram	21	308	391	83	—	1.0
259 M	Guava, with seeds—2 grams	21	310	357	47	—	1.0
263 M	Guava, with seeds—2 grams	21	308	388	80	—	1.0
265 M	Guava, with seeds—2 grams	21	317	381	64	—	1.0
262 F	Guava, without seeds—0.25 gram	21	301	341	40	—	0.5
266 F	Guava, without seeds—0.25 gram	21	299	376	77	—	0.5
278 F	Guava, without seeds....0.25 gram	21	304	353	49	++	0.2
280 F	Guava, without seeds—0.25 gram	21	300	267	—33	+++	0.1
297 M	Guava, without seeds—0.25 gram	21	326	466	140	—	0.8
260 F	Guava, without seeds—0.5 gram	21	288	293	5	?	0.5
287 M	Guava, without seeds—0.5 gram	21	322	425	103	—	0.7
299 M	Guava, without seeds—0.5 gram	21	315	410	95	—	0.7
376 F	Guava, without seeds—0.5 gram	21	323	407	84	—	0.9
391 M	Guava, without seeds—0.5 gram	21	328	421	93	—	0.8
397 M	Guava, without seeds—0.5 gram	21	302	347	45	—	0.7

TABLE 14.—*Results of feeding various amounts of Hawaiian fruits and fruit juices to guinea pigs as the sole source of vitamin C. (Continued)*

Guinea Pig No.	Kind and quantity of supplement fed daily	Period during which supplement was fed	Weight of Animals		Net gain or loss	Gross scurvy at autopsy	Histological examination of teeth, Höjer's rating
			When supplement started	At end of experiment			
		Days	Grams	Grams	Grams		
399 M	Guava, without seeds—0.5 gram	21	307	396	89	—	0.7
401 M	Guava, without seeds—0.5 gram	21	328	428	100	—	0.7
378 F	Guava, without seeds—1 gram	21	318	398	80	—	1.0
380 F	Guava, without seeds—1 gram	21	312	353	41	—	0.8
382 F	Guava, without seeds—1 gram	21	301	355	54	—	0.7
392 F	Guava, without seeds—1 gram	21	317	367	50	—	0.7
393 M	Guava, without seeds—1 gram	21	303	365	62	—	0.9
394 F	Guava, without seeds—1 gram	21	300	377	77	—	0.8
395 M	Guava, without seeds—1 gram	21	303	362	59	—	1.0
396 F	Guava, without seeds—1 gram	21	312	363	51	—	0.7
413 M	Guava, without seeds—1 gram	21	334	433	99	—	0.8
272 F	Guava Jelly*=3 cc. Guava juice	28	311	408	97	—	1.0
276 F	Guava Jelly*=3 cc. Guava juice	28	304	437	133	—	1.0
301 M	Guava Jelly*=3 cc. Guava juice	28	354	353	—1	—	1.0
307 M	Guava Jelly*=3 cc. Guava juice	28	324	423	99	tr	0.7
309 M	Guava Jelly*=3 cc. Guava juice	28	302	400	98	—	1.0
313 M	Guava Jelly*=3 cc. Guava juice	28	311	408	97	—	1.0
315 M	Guava Jelly*=3 cc. Guava juice	28	303	378	75	—	1.0
328 F	Guava Juice—2 cc.	28	304	367	63	—	1.0
357 M	Guava Juice—2 cc.	28	308	405	97	—	1.0
359 M	Guava Juice—2 cc.	28	355	450	95	—	1.0
361 M	Guava Juice—2 cc.	28	320	340	20	—	0.5
363 M	Guava Juice—2 cc.	28	322	368	46	—	0.7
222 F	Guava Juice—3 cc.	21	298	308	10	—	1.0
224 F	Guava Juice—3 cc.	21	314	360	46	—	1.0

* The weight of jelly varied from 3.6 to 4.0 grams.

TABLE 14.—*Results of feeding various amounts of Hawaiian fruits and fruit juices to guinea pigs as the sole source of vitamin C. (Continued)*

Guinea Pig No.	Kind and quantity of supplement fed daily	Period during which supplement was fed	Weight of Animals		Net gain or loss	Gross scurvy at autopsy	Histological examination of teeth, Höjer's rating
			When supplement started	At end of experiment			
		Days	Grams	Grams	Grams		
226 F	Guava Juice—3 cc.	21	300	330	30	—	1.0
228 F	Guava Juice—3 cc.	21	308	358	50	—	1.0
230 F	Guava Juice—3 cc.	21	298	296	—2	—	1.0
251 M	Guava Juice—3 cc.	21	304	432	128	—	1.0
268 F	Guava Juice—3 cc.	28	340	443	103	—	1.0
274 F	Guava Juice—3 cc.	28	290	396	106	—	1.0
303 M	Guava Juice—3 cc.	28	336	431	95	—	1.0
305 M	Guava Juice—3 cc.	28	328	397	69	—	0.8
311 M	Guava Juice—3 cc.	28	319	330	11	—	0.9
317 M	Guava Juice—3 cc.	28	315	428	113	—	1.0
321 M	Guava Juice—3 cc.	28	327	416	89	—	0.7
218 F	Guava Juice—4 cc.	21	320	352	32	—	1.0
220 F	Guava Juice—4 cc.	21	306	331	25	—	1.0
243 M	Guava Juice—4 cc.	21	324	406	82	—	1.0
247 M	Guava Juice—4 cc.	21	320	410	90	—	1.0
249 M	Guava Juice—4 cc.	21	326	388	62	—	1.0
253 M	Guava Juice—4 cc.	21	320	426	106	—	1.0
210 F	Guava Juice—5 cc.	21	301	336	35	—	1.0
212 F	Guava Juice—5 cc.	21	257	332	75	—	1.0
214 F	Guava Juice—5 cc.	21	312	358	46	—	1.0
216 F	Guava Juice—5 cc.	21	306	336	30	—	1.0
241 M	Guava Juice—5 cc.	21	320	346	26	—	1.0
245 M	Guava Juice—5 cc.	21	304	406	102	—	1.0
420 F	Orange juice, California—3 cc.	21	314	382	68	—	1.0
426 F	Orange juice, California—3 cc.	21	304	343	39	—	1.0
430 F	Orange juice, California—3 cc.	21	290	331	41	—	1.0
455 M	Orange juice, California—3 cc.	21	300	353	53	—	1.0

TABLE 14.—*Results of feeding various amounts of Hawaiian fruits and fruit juices to guinea pigs as the sole source of vitamin C. (Continued)*

Guinea Pig No.	Kind and quantity of supplement fed daily	Period during which supplement was fed	Weight of Animals		Net gain or loss	Gross scurvy at autopsy	Histological examination of teeth, Höjer's rating
			When supplement started	At end of experiment			
		Days	Grams	Grams	Grams		
422 F	Orange juice, Kona—3 cc.	22	305	369	64	—	1.0
424 F	Orange juice, Kona—3 cc.	21	302	325	23	—	1.0
428 F	Orange juice, Kona—3 cc.	21	315	366	51	—	0.9
453 M	Orange juice, Kona—3 cc.	21	310	381	71	—	1.0
457 M	Orange juice, Kona—3 cc.	21	342	449	107	—	1.0
286 F	Papaya—2 grams	28	309	284	—25	?	0.5
290 F	Papaya—2 grams	28	301	397	96	—	1.0
296 F	Papaya—2 grams	28	303	375	73	—	0.9
298 F	Papaya—2 grams	28	301	331	30	—	0.7
300 F	Papaya—2 grams	28	304	410	106	—	1.0
302 F	Papaya—2 grams	28	305	375	70	—	0.5
329 M	Papaya—2 grams	28	336	458	122	—	1.0
331 M	Papaya—2 grams	28	310	401	91	—	1.0
333 M	Papaya—2 grams	28	344	370	26	—	0.7
337 M	Papaya—2 grams	28	316	411	95	—	0.8
339 M	Papaya—2 grams	28	311	406	95	—	1.0
341 M	Papaya—2 grams	28	313	397	84	—	1.0
282 F	Papaya—3 grams	28	313	359	46	—	1.0
284 F	Papaya—3 grams	28	303	340	37	—	0.7
288 M	Papaya—3 grams	28	310	339	29	—	0.5
310 F	Papaya—3 grams	28	303	344	41	—	0.8
312 F	Papaya—3 grams	28	302	385	83	—	0.9
325 M	Papaya—3 grams	28	326	462	136	—	1.0
327 M	Papaya—3 grams	28	308	423	115	—	1.0
353 M	Papaya—3 grams	28	308	279	—29	—	0.8
355 M	Papaya—3 grams	28	323	320	—3	—	0.9

TABLE 14.—*Results of feeding various amounts of Hawaiian fruits and fruit juices to guinea pigs as the sole source of vitamin C. (Continued)*

Guinea Pig No.	Kind and quantity of supplement fed daily	Period during which supplement was fed	Weight of Animals		Net gain or loss	Gross scurvy at autopsy	Histological examination of teeth, Höjer's rating
			When supplement started	At end of experiment			
		Days	Grams	Grams	Grams		
480 F	Passion-fruit juice—2 cc.	21	300	325	25	tr	0.5
486 F	Passion-fruit juice—2 cc.	21	311	330	19	—	0.7
503 M	Passion-fruit juice—2 cc.	21	301	355	54	—	0.8
505 M	Passion-fruit juice—2 cc.	21	300	374	74	—	0.7
511 M	Passion-fruit juice—2 cc.	21	310	335	25	—	0.4
482 F	Passion-fruit juice—4 cc.	21	300	332	32	—	0.7
484 F	Passion-fruit juice—4 cc.	21	303	309	6	+	0.5
513 M	Passion-fruit juice—4 cc.	21	301	369	68	—	0.7
176 M	Pineapple juice, fresh—3 cc.	89	306	562	256	—	0.5
185 M	Pineapple juice, fresh—3 cc.	90	318	534	216	?	0.4
186 F	Pineapple juice, fresh—3 cc.	21	304	326	22	—	----[4]
191 M	Pineapple juice, fresh—3 cc.	21	304	294	—10	tr	----[4]
192 F	Pineapple juice, fresh—3 cc.	21	304	320	16	++	0.2
193 M	Pineapple juice, fresh—3 cc.	21	358	358	0	—	----[4]
203 M	Pineapple juice, fresh—3 cc.	21	320	284	—36	+	0.2
207 M	Pineapple juice, fresh—3 cc.	21	328	404	76	—	0.7
215 M	Pineapple juice, fresh—3 cc.	22	313	392	79	+	0.5
225 M	Pineapple juice, fresh—3 cc.	21	311	392	81	—	0.7
227 M	Pineapple juice, fresh—3 cc.	20	314	366	52	—	0.5
229 M	Pineapple juice, fresh—5 cc.	21	300	356	56	—	0.8
231 M	Pineapple juice, fresh—5 cc.	21	321	362	41	—	0.8
233 M	Pineapple juice, fresh—5 cc.	21	310	327	17	—	0.5
208 F	Pineapple juice, fresh—6 cc.	21	304	362	58	—	0.8
235 M	Pineapple juice, fresh—6 cc.	21	304	307	3	—	0.5
237 M	Pineapple juice, fresh—6 cc.	21	270	288	18	?	0.7
239 M	Pineapple juice, fresh—6 cc.	21	322	424	102	—	0.9

[4] Histological preparation unsatisfactory.

TABLE 14.—*Results of feeding various amounts of Hawaiian fruits and fruit juices to guinea pigs as the sole source of vitamin C. (Continued)*

Guinea Pig No.	Kind and quantity of supplement fed daily	Period during which supplement was fed	Weight of Animals		Net gain or loss	Gross scurvy at autopsy	Histological examination of teeth, Höjer's rating
			When supplement started	At end of experiment			
		Days	Grams	Grams	Grams		
388 F	Pineapple juice, fresh—6 cc.	21	312	342	30	+	0.4
390 F	Pineapple juice, fresh 6 cc.	21	306	380	74	—	0.7
403 M	Pineapple juice, fresh—6 cc.	21	315	371	56	tr	0.5
405 M	Pineapple juice, fresh—6 cc.	21	334	311	—23	++	0.2
407 M	Pineapple juice, fresh—6 cc.	21	328	404	76	—	0.5
409 M	Pineapple juice, fresh—6 cc.	21	316	404	88	—	0.7
320 F	Poha—2 grams	23	309	329	20	—	0.8
326 F	Poha—2 grams	28	335	360	25	—	0.7
400 F	Poha—3 grams	28	316	405	89	—	0.9
402 F	Poha—3 grams	28	305	298	—7	++	0.2
429 M	Poha—3 grams	28	323	384	61	+	0.4
318 F	Poha—4 grams	28	313	278	—35	—	1.0
324 F	Poha—4 grams	28	311	392	81	—	1.0
431 M	Poha—4 grams	29	325	430	105	—	1.0
433 M	Poha—4 grams	28	314	402	88	—	1.0
316 F	Poha—5 grams	28	304	390	86	—	1.0
322 F	Poha—5 grams	23	315	384	69	—	1.0
442 F	Soursop juice—5 cc.	21	314	382	68	—	0.5
444 F	Soursop juice—5 cc.	21	319	284	—35	+	0.4
446 F	Soursop juice—5 cc.	21	305	266	—39	—	0.5
456 F	Soursop juice—5 cc.	21	308	291	—17	+	0.2
469 M	Soursop juice—5 cc.	21	321	341	20	—	0.7
473 M	Soursop juice—5 cc.	21	306	400	94	+	0.5
485 M	Soursop juice—5 cc.	21	302	361	59	—	0.7
487 M	Soursop juice—5 cc.	21	300	358	58	—	0.7
448 F	Soursop juice—10 cc.	21	301	294	—7	+	0.4

TABLE 14.—*Results of feeding various amounts of Hawaiian fruits and fruit juices to guinea pigs as the sole source of vitamin C. (Continued)*

Guinea Pig No.	Kind and quantity of supplement fed daily	Period during which supplement was fed	Weight of Animals		Net gain or loss	Gross scurvy at autopsy	Histological examination of teeth, Höjer's rating
			When supplement started	At end of experiment			
		Days	Grams	Grams	Grams		
450 F	Soursop juice—10 cc.	21	303	268	—35	+	0.4
452 F	Soursop juice—10 cc.	21	318	371	53	—	0.8
454 F	Soursop juice—10 cc.	21	305	316	11	—	0.8
475 M	Soursop juice—10 cc.	21	354	381	27	—	0.5
354 F	Tamarind—1 gram	14	301	255	—46	Died	....[5]
356 F	Tamarind—1 gram	9	306	220	—86	Died	....[5]
360 F	Tamarind—1 gram	10	307	229	—78	Died	....[5]
368 F	Tamarind—1 gram	21	314	220	—94	+++	0.0
372 F	Tamarind—1 gram	21	307	243	—64	+++	0.0
374 F	Tamarind—1 gram	21	323	239	—84	+++	0.2
379 M	Tamarind—1 gram	10	313	246	—67	Died	....[5]
383 M	Tamarind—1 gram	21	305	312	7	+	0.2
385 M	Tamarind—1 gram	21	314	335	21	+	0.4
387 M	Tamarind—1 gram	21	314	363	49	+	0.4
358 F	Tamarind—2 grams	28	315	190	—125	+++	....[5]
362 F	Tamarind—2 grams	11	303	261	—42	Died	....[5]
364 F	Tamarind—2 grams	16	310	224	—86	Died	....[5]
366 F	Tamarind—2 grams	10	308	212	—96	Died	....[5]
377 M	Tamarind—2 grams	7	320	255	—65	Died	....[5]
389 M	Tamarind—2 grams	21	315	246	—69	+++	0.0

[5] Teeth not saved for histological examination.

Discussion of the conduct and results of the vitamin tests

The results of the vitamin tests are summarized in Tables 9, 10, 11, 12, 13 and 14, and by means of Figures 14, 15 and 16. The explanatory statements and discussion which follow are given for the benefit of those interested in the details and technique of vitamin testing.

VITAMIN A.

The average gain of the 36 positive controls fed carotene for 6 weeks was 87 grams.

Figs: The average gain of the 4 positive controls fed carotene is less than the average given above probably because all 4 rats were females. The 10 rats fed 5 grams of figs gained uniformly.

Guavas: For the feeding experiments, guavas were prepared twice a week by scooping out the inner portion from 3 or more guavas, separating the seeds from the pulp by pressing in an 18-mesh sieve and adding the sieved pulp to the finely chopped outer rind.

Although there was good division of the sexes, the average gain of the 7 rats fed carotene was greater than any other group of positive controls. One rat fed carotene is not included in the summary or curves because it died 32 days after the supplement was started.

One rat fed 2 grams of guavas and 2 fed 1 gram are not included in the summary or curves because they died 16, 20 and 30 days after the supplements were started.

The results of feeding 4 grams of guava jelly (equivalent to 3 cc. of guava juice) to 8 rats are not included in the summary or curves because the rats lived no longer than the control.

Papayas: It should be noted that the data for the rats fed papaya are for a 5-week feeding period whereas all others except one group fed pohas are for a 6-week feeding period.

One rat fed 0.1 gram papaya and 1 positive control fed carotene are not included in the summary or curves because they died 33 and 14 days after the supplements were started.

Pineapple: Two rats fed 3 grams of pineapple are not included in the curves and summary because they died 20 and 38 days after the supplements were started. Three rats fed 2 grams of pineapple were not included because they died 31, 24 and 25 days after the supplements were started.

Pohas: One positive control that lost weight rapidly toward the end of the experiment is not included in the summary and curves as all the other 8 gained uniformly and well.

Four rats were fed the supplement of 0.1 gram of pohas for 5 weeks instead of 6 weeks because the fruit was not available.

Soursop and tamarinds: Because the flesh of the soursop appears to have no yellow pigment it was not tested for vitamin A. Tamarinds appear to be low in vitamin A as 3 rats fed 1 gram of tamarind died

4 to 6 weeks after the supplements were started. It was not possible to induce them to eat larger supplements.

Vitamin B.

Results of preliminary tests using varying quantities of the International Standard and the fruits are not included in the summary in order to save space. For the final tests, the aim was to choose weights of the supplementary fruits which would result in approximately the same gain as when 0.005 gram of the International Standard was fed. The average gain of 33 rats fed daily except Sunday supplements of 0.005 gram of International Standard was 43 grams. When the 9 positive control rats of the papaya group which gained much more than the others are excluded the average gain is 36 grams.

The growth response of the rats used for the vitamin B tests was very uniform with few exceptions. The records of 1 negative control for the fig group and 1 for the guava group were discarded because after losing weight rapidly the rats suddenly began to gain, apparently because of marked coprophagy which could not be controlled.

No comments on specific groups are necessary except for tamarinds. The records of 21 rats fed tamarinds in the preliminary experiments are not included in the summary and curves because of conflicting results. Nine rats fed 1 gram of tamarind gained an average of 54 grams in 6 weeks and 4 rats fed 0.5 gram gained an average 49 grams in 6 weeks. The tests were made during the months of August, September and October 1934. Because the tamarind appeared to have such a high vitamin B value, 0.5 gram of the same material previously used was again fed to 8 rats during November and December 1934, and January 1935. The growth response was about one-third the previous one as the 8 rats gained an average of 14 grams in 6 weeks.

It was thought that perhaps there was a loss of vitamin B due to storage but when 1 gram of fresh material (1935 crop) was fed along with a like quantity of the tamarind pulp that had been stored at from 34° to 38° F. for 1 year, the growth curves were identical so that the same line is necessary to represent both curves. Obviously then there is no loss of vitamin B resulting from the storage at a cool temperature and it is highly probable that the acidity of the pulp would prevent loss of vitamin B even at room temperature.

Using tamarind pulp as the sole source of vitamin B, a fourth set of feeding experiments was carried out during the months of November and December 1935. Nineteen rats, including positive and negative controls, were used. The results may be summarized as follows: 5 rats fed 0.5 gram tamarind gained an average of 41 grams, 5 rats fed 1.0 gram tamarind gained an average of 63 grams, 6 rats fed 0.005 gram International Standard gained an average of 36 grams.

The results confirm the first and third sets of experiments and prove tamarinds to be an excellent source of vitamin B.

Vitamin G

Results of preliminary tests are not included in the final tables and curves.

No special comment regarding the vitamin G tests is necessary with few exceptions. The records of 1 negative control used for the papaya experiments and 1 for the poha experiments were omitted from the summary because they made very unusual gains in weight apparently due to coprophagy. The records of 2 rats fed 2 grams of figs were omitted for the same reason.

No experiments were made to test the vitamin G content of soursop.

No final tests were made but preliminary experiments using 3 rats indicate that tamarinds are a good source of vitamin G. Two rats fed 1 gram daily gained 11 grams per week and 1 rat fed 0.5 gram daily gained 5 grams per week over a 5-week test period.

Vitamin C

Coconut water: It was possible to feed 20 cc. of coconut water only by withholding tap water, so that it was not feasible to give a larger quantity which might consistently have protected the guinea pigs from gross scurvy.

Figs: Since such a large quantity of figs as 10 grams failed to protect guinea pigs from scurvy, additional experiments were not made as it seemed obvious that figs were a poor antiscorbutic. The tests were made at a good season when the fruit was of fine quality.

Guavas: The vitamin C content of guavas is probably influenced by the season of the year and the quality of the fruit. For example, animals numbered 262, 266 and 297, which were fed 0.25 gram of guava without seeds near the middle of the guava season, were completely protected from gross scurvy, but animals 278 and 280, which showed moderate and severe scurvy, were fed the same quantity several months later at the very end of the season when the quality of the fruit was poor. About 11 percent of the weight of guavas is seeds so that 1.0 gram of whole guavas is equivalent to approximately 0.9 gram of guavas without seeds. Animals numbered 257 and 261 fed 1 gram of whole guavas near the beginning of the fruiting season in 1933 showed a perfect histological picture, whereas only 2 animals out of a group of 9 fed 1 gram of guavas without seeds in the middle of the 1934 season showed no histological changes in the teeth.

As the "guava juice" (page 36) constituted a watery extract of the guavas, it was not anticipated that its vitamin C value would be particularly high. Four and 5 cc. were first fed daily. It was found that these quantities completely protected the teeth of guinea pigs from histological changes. Of the 13 guinea pigs fed 3 cc. of guava juice all but 3 had the teeth completely protected. These 3 were part of a group of 7 animals fed from juice prepared a year following the juice which was fed to the first 6 animals listed as receiving 3 cc. of guava juice.

Orange juice: The juice was prepared as for analysis but strained through 2 thicknesses of cheesecloth instead of through a strainer. The results in Table 14 indicate that the juice of Hawaiian oranges has an antiscorbutic value equal to that of good quality California oranges tested simultaneously.

Papayas: Of 12 guinea pigs fed 2 grams of papaya only 1 was not protected from gross scurvy. Not all of the 8 animals fed 3 grams of papaya daily had the teeth completely protected from histological changes. These variations may be due to the quality of the papaya as well as individual differences in the guinea pigs.

Passion-fruit juice: The passion-fruit used for the feeding experiments was grown in the Kona district of the island of Hawaii and a fresh lot was shipped each week to the nutrition laboratory. Each week the passion-fruit juice was prepared as was that for analysis. The juice was then frozen and the quantity needed for daily feeding was removed from the freezing chamber and brought to room temperature.

As the product was consistently the same, the lack of uniformity in the results must be due to variations in the guinea pigs.

Pineapple juice: Pineapple juice was prepared as for analysis except that it was squeezed in 2 thicknesses of cheesecloth. When fed at a level of 3 cc. pineapple juice usually failed to protect guinea pigs from gross scurvy. Even 6 cc. protected only 6 out of 10 guinea pigs from gross scurvy and in no case protected the teeth completely from histological changes.

Pohas: Two of the 3 guinea pigs fed 3 grams of pohas near the end of the fruiting season were not protected from gross scurvy but those fed 4 grams both at the beginning and end of the season were protected not only from gross scurvy but from histological changes in tooth structure. The teeth of 2 animals fed 2 grams of pohas at the beginning of the fruiting season were not protected but no gross symptoms of scurvy were observed at autopsy.

Soursop juice: The juice was prepared by squeezing pieces of pulp freed from seeds in 2 thicknesses of cheesecloth and freezing. The quantity needed daily was brought to room temperature before feeding.

The records of 9 guinea pigs fed 5 cc. of soursop juice, in addition to those shown in Table 14 are not recorded, for it was first thought that the quality of the fruit may have been responsible for lack of protection from scurvy but the results for 8 animals shown in Table 14 are practically identical. Even 10 cc. of soursop juice did not consistently protect from gross scurvy.

Tamarinds: At the beginning of the experiment the tamarind pulp was prepared by adding a little sugar and mixing with distilled water so that it could be fed by means of a hypodermic syringe as the animals would not take the material voluntarily. As the guinea pigs failed to survive, the natural acidity of the tamarind was partially neutralized by thoroughly mixing 2 cc. of 0.5 normal and later 0.75 normal sodium hydroxide with 1 gram of tamarind pulp just before feeding.

Animals numbered 354, 356 and 377 received the tamarind without addition of alkali and died 7 to 14 days after tamarind feeding began showing little or no evidence of scurvy. Animals numbered 379 and 360 received the untreated tamarind pulp mixed with water for 6 days

and partially neutralized pulp for 4 days and died showing little evidence of gross scurvy.

Guinea pigs 362, 364 and 366 received partially neutralized tamarind. Number 362 died and no autopsy was made. Autopsy of numbers 364 and 366 after death showed 364 to have hemorrhages of the stomach and caecum and 366 to have no gross scurvy.

All animals that survived the feeding period of 21 days received tamarind that had the acidity partially neutralized with either 0.5 or 0.75 normal sodium hydroxide. At autopsy they showed mild to severe scurvy but no other abnormalities.

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